Atlantic Richfield Company

Anthony R. Brown
Project Manager, Mining

4 Centerpointe Drive, 2nd Floor Suite 200
La Palma, CA 90623-1066
Office: (714) 228-6770
Fax: (714) 228-6749
E-mail: Anthony.Brown@bp.com

November 2, 2016

Lynda Deschambault
Remedial Project Manager, Superfund Division
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street, 10th Floor (SFD 7-1)
San Francisco, California 94105

Subject: **Interim 2015-2016 Upper Tributary Report**
Leviathan Mine Site
Alpine County, California

Dear Ms. Deschambault:

In response to the U.S. Environmental Protection Agency's (U.S. EPA's) comments on previous reports related to the Upper Tributary area investigations as provided in letters to Atlantic Richfield Company (Atlantic Richfield) dated September 14, 2015, and March 21, 2016. Atlantic Richfield is submitting this draft *Interim 2015-2016 Upper Tributary Report, Leviathan Mine Site, Alpine County, California*. This report is submitted in partial fulfillment of the requirements of the *Statement of Work attached to the Administrative Order for Remedial Investigation and Feasibility Study, Comprehensive Environmental Response, Compensation, and Liability Act Docket No. 2008-18* issued by the U.S. EPA on June 23, 2008.

When the original interim report was submitted, Atlantic Richfield did not intend for it to be the start of an annual reporting process. Rather, it was an interim evaluation to assess the feasibility of installing a subsurface barrier in the Upper Tributary area and to communicate with the U.S. EPA about data interpretation and the conceptual model for the potential interception of subsurface flow as requested by the U.S. EPA in its approval of *On-Property Focused Remedial Investigation Work Plan Amendment No. 2, Additional Characterization of the Upper Tributary Area, Leviathan Mine Site, Alpine County, California*.

The 2015-2016 wet season is the first period during monitoring in the Upper Tributary area where abnormally dry conditions have not occurred and, therefore, the indication of conditions where water and flow were present, thereby adding to the evaluation of the dynamics of water flow in the area. Atlantic Richfield will continue to collect data in the Upper Tributary area. Future evaluations of these data will be included as part of the Groundwater Technical Data Summary Report.

If you have any questions or comments, please feel free to contact me at (714) 228-6770 or anthony.brown@bp.com.

Sincerely,

Anthony R. Brown

Anthony R. Brown
Project Manager, Mining

Enclosure: Interim 2015-2016 Upper Tributary Report, Leviathan Mine Site, Alpine County, California

cc: Gary Riley, U.S. Environmental Protection Agency, Region 9 – via electronic copy
John Hillenbrand, U.S. Environmental Protection Agency, Region 9 – via electronic copy
Douglas Carey, Lahontan Regional Water Quality Control Board – via electronic copy
Nathan Block, Esq., BP – via electronic copy
Adam Cohen, Esq., Davis Graham & Stubbs, LLP – via electronic copy
Sandy Riese, EnSci, Inc. – via electronic copy
Marc Lombardi, Amec Foster Wheeler – via electronic copy
Grant Ohland, Ohland HydroGeo, LLC – via electronic copy
Dave McCarthy, Copper Environmental Consulting – via electronic copy
Cory Koger, U.S. Army Corps of Engineers – via electronic copy
Greg Reller, Burleson Consulting – via electronic copy
Diane Vitols, Esq., Washoe Tribe of California and Nevada – via electronic copy
Fred Kirschner, AESE, Inc. – via electronic copy

P:\Project\13000s\13091 Leviathan\4000 Regulatory\4150 RIFS Reports\6 Upper Trib\161102 Report\161102 Upper Trib Cover Letter.docx

INTERIM 2015-2016 UPPER TRIBUTARY REPORT

Leviathan Mine Site
Alpine County, California

Prepared for:
Atlantic Richfield Company
La Palma, California

Prepared by:
Amec Foster Wheeler
Environment & Infrastructure, Inc.
Rancho Cordova, California

November 2, 2016
DRAFT

Project No. 0013091150

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLES

FIGURES

GRAPHS

TABLE OF CONTENTS
(Continued)

APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

ABA	acid-base account
Atlantic Richfield	Atlantic Richfield Company
amsl	above mean sea level
bgs	below ground surface
Cascade	Cascade Drilling L.P.
CD	compact disk
cfs	cubic feet per second
DI WET	deionized water waste extraction test
gpm	gallons per minute
LRWQCB	Lahontan Regional Water Quality Control Board
RI/FS	Remedial Investigation/Feasibility Study
site	Leviathan Mine Site
Summit	Summit Engineering Corporation
TOC	total organic carbon
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

INTERIM 2015-2016 UPPER TRIBUTARY REPORT
Leviathan Mine Site
Alpine County, California

1.0 INTRODUCTION

This report presents results of data collected in 2015 through mid-2016 at the Upper Tributary area of the Leviathan Mine Site (the site) located in Alpine County, California (Figure 1-1). It also summarizes field activities and results for work conducted in prior years that were previously reported (2012b and 2015b). Field work performed in 2011 and 2012 and monitoring performed beginning in late 2012 through mid-2016 were conducted to support an assessment of the feasibility of installing a subsurface flow barrier in the Upper Tributary area (Figure 1-2). Atlantic Richfield Company (Atlantic Richfield) performed the activities described herein in partial fulfillment of the requirements of the Statement of Work attached to the Administrative *Order for Remedial Investigation and Feasibility Study, Comprehensive Environmental Response, Compensation, and Liability Act Docket No. 2008-18* issued by the U.S. Environmental Protection Agency (U.S. EPA) on June 23, 2008. This report addresses comments provided by the U.S. EPA on previous reports related to the Upper Tributary investigations as provided in letters to Atlantic Richfield dated September 14, 2015, (U.S. EPA, 2015) and March 21, 2016 (U.S. EPA, 2016). The stream-flow data evaluated in this report extend through May 31, 2016, to capture spring runoff; however, the water-level data extend through July 31, 2016 in some cases because in some piezometers water levels were still rising at the end of May and the full effect of spring runoff at that time not be observed (Atlantic Richfield, 2016b). Although this report presents a limited data set, data collection continued in 2016.

2.0 TREATABILITY STUDY OBJECTIVES

This study consists of hydrogeological data collection needed to evaluate the feasibility of a cutoff wall on the Upper Tributary. The following data gaps were identified in *Additional Characterization of the Upper Tributary Area* (Atlantic Richfield, 2012a). This information will assist in evaluating the flux of surface water and groundwater from the Upper Tributary watershed that may be contributing to acid drainage into Leviathan Creek study area.

1. What volume of surface water enters the mine site year-round through the Upper Tributary?
2. What volume of surface water is lost or gained upstream of the concrete-lined Upper Tributary channel?

3. What volume of water, if any, leaks out or leaks into the concrete-lined Upper Tributary channel?

4. What volume of non-impacted surface water flows through the concrete-lined Upper Tributary channel and is discharged to Leviathan Creek?

5. What is the nature and magnitude of surface water/groundwater interaction in the Upper Tributary where it contacts mine waste beneath Ponds 2S and 2N?

6. Is groundwater flowing at the mine waste/native materials interface beneath Ponds 2S and 2N?

7. If there is no interfacial flow, what are the possible sources of groundwater entering surface or groundwater within or adjacent to Leviathan Creek from the Upper Tributary watershed?

8. If groundwater is flowing at the interface, can it be feasibly controlled and/or intercepted?

3.0 FIELD ACTIVITIES

In 2011, a drilling program was conducted in the Upper Tributary area (Atlantic Richfield, 2012b) to provide hydrogeologic information needed to evaluate the feasibility of a subsurface flow barrier. The 2011 Upper Tributary drilling program consisted of advancing four boreholes, collecting soil and rock samples for physical property testing, installing piezometers, and performing hydraulic testing at the new piezometers and a nearby monitoring well (MW-07).

Data collected in 2011 were combined with other site data to develop a conceptual understanding of the hydrogeological system in the Upper Tributary area and to identify the data gaps listed in Section 2.0. The following field activities were performed in 2012 to address these data gaps:

- installed stream-flow measurement stations and instrumented an existing U.S. Geological Survey (USGS) stream-flow measurement station in the Upper Tributary;
- performed falling-head percolation tests in the drainage swale west of Pond 2N;
- installed drive-point piezometers in the upstream portion of the Upper Tributary; and,
- installed shallow conventional piezometers along the Upper Tributary and the western and northern edges of Ponds 2N and 2S.

Seasonal water levels and stream flow along the Upper Tributary have been monitored since late 2012. Related field activities are summarized in the following sections.

In late August 2012, the Lahontan Regional Water Quality Control Board (LRWQCB) removed accumulated sedimentation and vegetation within the concrete-lined portion of the Upper Tributary (LRWQCB, 2013). Approximately, 190 cubic yards of sediment and vegetation were removed.

3.1 STREAM-FLOW MEASUREMENT

The stream-flow measurement stations collect data that are used to estimate the:

- quantity of surface water entering the site annually at the Upper Tributary;
- volume of surface water that is lost or gained upstream of the concrete-lined portion of the Upper Tributary and along the lined portion of the Upper Tributary; and
- quantity of surface water that is discharged from the Upper Tributary to Leviathan Creek.

Two surface water stream-flow measurement stations, SF-01 and SF-02, were installed in the Upper Tributary in 2012 (Figure 3-1). Station SF-01 was installed in the natural portion of the Upper Tributary upstream of the concrete-lined portion of the tributary. Station SF-02 was installed in the concrete-lined portion of the tributary adjacent to the south side of Pond 2S. Additionally, an existing USGS stream-flow measurement station on the Upper Tributary at its confluence with Leviathan Creek was instrumented; this data collection point is designated as stream-flow measurement station SF-03. Syblon Reid Construction of Folsom, California, constructed the flow measurement stations between October 1 and October 26, 2012.

The stream-flow measurement stations were constructed with either a concrete (station SF-01) or wooden (station SF-02) headwall with a stainless-steel 90-degree V-notch weir plate and a staff gage. Solinst® Edge, Model 3001 pressure transducers with built-in data loggers were installed approximately 3 to 4 feet upstream of each weir. Stainless-steel Unistrut® frames and rigid conduit were used to anchor and hold the transducers. The transducers were placed approximately 2 inches above the stream bottom and programmed to measure and record temperature and water pressure (to calculate water height above the sensors) at 15-minute intervals. A transducer was installed at station SF-03 using similar materials and was also programmed to measure temperature and water pressure at 15-minute intervals. Staff gages were installed at all three flow measurement stations.

Construction drawings with information about how the flow measurement stations were developed and photographs of the flow measurement stations are provided in Appendix A. On November 14, 2012, Summit Engineering Corporation (Summit) of Reno, Nevada, surveyed the elevation of the top of the weir plate at station SF-01. The elevation of the top of the weir plate at station SF-02 was not surveyed at that time because of seasonal ice formation and limited accessibility. Amec Environment & Infrastructure, Inc. (AMEC), surveyed horizontal coordinates of the weirs on May 22, 2012, using a Trimble® GeoXH handheld global positioning system unit. In fall 2013, Summit collected additional survey data (including weir dimensions, V-notch elevations, and staff gage elevations) at all three flow measurement stations. The coordinates and elevations of the flow measurement stations are provided in Table 3-1.

The flow through a weir is a function of the height of the water surface above the weir. Data from the pressure transducers at stations SF-01 through SF-03 were processed to calculate the height of the water surface above the V-notch weir. The height above the V-notch weir was then used to calculate a stream flow using a flow equation for a fully contracted 90-degree V-notch weir.

3.2 METEOROLOGICAL MONITORING

Precipitation data for the Upper Tributary study is collected from meteorological station MET-01 as part of Atlantic Richfield's ongoing meteorological monitoring program. Three meteorological stations (MET-01, MET-02, and MET-03) were originally monitored in the Leviathan Creek Study Area; however, because data from the three stations were largely redundant, only station MET-01 is currently operating and stations MET-02 and MET-03 have been dismantled (Atlantic Richfield, 2015a). Routine inspections are conducted to ensure that the instrumentation is unobstructed and operating correctly. Data collected by multiple sensors are downloaded approximately monthly during the field season.

Station MET-01 is located adjacent to the operator's trailer in the Pond 4 parking area. Station MET-01 is fitted with sensors to measure wind speed, wind direction, temperature, relative humidity, solar radiation, and barometric pressure. The station is equipped with an internally heated precipitation gauge that allows both frozen and liquid precipitation to be measured year round.

3.3 DRIVE-POINT PIEZOMETER INSTALLATION

Drive-point piezometers were installed to characterize the hydraulic relationship between surface water and shallow groundwater near where the Upper Tributary encounters mine waste near Pond 2S. Differences in water-level elevation in adjacent piezometers completed at different depths are used to evaluate if a stream is gaining water from or losing water to groundwater. Six drive-point piezometers, DPZ-01 through DPZ-06, were installed adjacent to the Upper Tributary on October 25, 26, and 31, 2012 (Figure 3-1). Construction details are provided in Table 3-2. The piezometers were installed along the north bank of the tributary immediately upstream and immediately downstream of a concrete structure in the tributary.

Solinst® Model 615N drive-point piezometers with a stainless-steel screen were installed. Each screen is 0.75 inches in diameter and 0.5 feet in length. The screens were connected to 1-inch-diameter by 3-foot-long stainless-steel extensions with National Pipe Tapered threads at each end. A 1- to 0.75-inch-diameter threaded bell reducer was used at the joint of the screen and extension. Teflon tape was used at each joint.

During installation, the drive-point screen and extension pipe were driven into the ground using a slide hammer. Extension pieces were added as needed as the piezometer was driven into the ground. After driving the piezometer to total depth (typically refusal), the drive head was removed and a plastic compression fitting was fitted onto the top of the above-ground portion of the extension pipe. The compression fitting has a hole for a transducer cable to pass through. Solinst® Levelogger Edge Model 3001 transducers were installed near the bottom of the piezometers on October 31, 2012, and November 1, 2012. Each transducer has a cable that extends from the sensor to the top of the piezometer casing and can be connected to a laptop computer to download recorded data or view it in real-time. Transducers were programmed to collect measurements every hour.

Summit surveyed the drive-point piezometers on November 14, 2012. Construction information and the horizontal and vertical coordinates are provided in Table 3-2.

3.4 CONVENTIONAL PIEZOMETER INSTALLATION

Conventional piezometers (piezometers) were installed to:

- characterize the surface water/groundwater interaction where the surface water/groundwater contacts mine waste beneath Ponds 2N and 2S;
- characterize whether groundwater may be flowing through the mine waste beneath Ponds 2N and 2S; and
- provide information needed to assess whether groundwater can be controlled or intercepted and identify other possible sources of groundwater entering surface water or groundwater within or adjacent to Leviathan Creek from the Upper Tributary watershed.

Ten boreholes were advanced during the 2012 field season and completed as piezometers (Figure 3-1). Piezometer construction details are summarized in Table 3-3. The piezometers were installed using the sonic drilling method. Drilling activities began on September 26, 2012, and were concluded on October 30, 2012. Cascade Drilling, L.P. (Cascade), of Rancho Cordova, California, performed drilling, sampling, and piezometer installation activities. Cascade is a State of California-licensed (C-57) drilling contractor. Cascade used a Geoprobe 8140 LS track-mounted limited-access drill rig and a Sonic Drill Corporation truck-mounted Sonicor 50K drill head to perform the drilling activities.

Continuous soil and rock core samples were collected during drilling using nominal 4-inch and 6-inch outer-diameter by 5- or 10-foot-long coring tools. Following coring of a 5- or 10-foot interval, a nominal 6-inch-diameter drill casing was advanced into the borehole to seal off or "case" the cored interval before the borehole was advanced further. This drilling method facilitates observation of the depth that groundwater (if any) is first encountered in the uncased borehole and the collection of grab groundwater samples as drilling progresses. The 6-inch-diameter casing was advanced to the approximate total depth of the borehole followed by piezometer installation.

3.4.1 Soil and Rock Sampling, Testing, and Logging

Soil and rock samples were collected using either the nominal 4- or 6-inch-diameter sonic coring tools or a California modified split-spoon sampler lined with 6-inch-long stainless-steel sleeves. Samples selected for laboratory analysis were labeled, placed in an ice-cooled chest, and transported to the laboratory under chain of custody protocol. Samples were selected to 1) provide information regarding the material and hydraulic properties of potential water-bearing zones encountered during drilling and 2) to characterize the mine waste.

The soil and rock samples were tested for particle size distribution (sieve and hydrometer), Atterberg Limits, and vertical hydraulic conductivity by AMEC Materials Testing Laboratory in Reno, Nevada. Chemical analysis consisted of remedial investigation/feasibility study (RI/FS) metals, deionized water waste extraction test (DI WET) for RI/FS metals, acid-base account (ABA), and total organic carbon (TOC). Test America, Inc. of Irvine, California, analyzed the samples for RI/FS metals, DI WET for RI/FS metals, and TOC. SVL Analytical, Inc. of Kellogg, Idaho, analyzed the samples for ABA.

Soil and rock core samples were described by the field geologist using the ASTM International Standard D2488-09a for guidance, which is based on the Unified Soil Classification System. Exploration borehole logs were prepared for each borehole and include a piezometer construction schematic. The exploration borehole logs are provided in Appendix B.

3.4.2 Grab Groundwater Sampling and Analysis

To identify whether water was entering each borehole, a water-level indicator was lowered to the bottom of the borehole and the water level was monitored for a minimum of 5 minutes. All boreholes were monitored during drilling, but groundwater was encountered during drilling in the

Upper Tributary at only one borehole (B-61/PZ-51). A groundwater grab sample was collected when groundwater was first encountered.

The grab groundwater sample from borehole B-61/PZ-51 was analyzed for field water quality parameters (temperature, pH, specific electric conductance, dissolved oxygen, and oxidation-reduction potential). The concentrations of ferrous iron and sulfate were also measured in the field using a HACH Portable Colorimeter.

3.4.3 Piezometer Installation

At most locations, piezometers were installed at depths shallower than the total borehole depth. In these cases, the bottom of the borehole was sealed by first removing slough material that had accumulated in the bottom of the borehole using the coring tool and advancing the 6-inch-diameter drill casing to the borehole total depth. The borehole was then backfilled to the piezometer design-specified depth with a low permeability material consisting of medium bentonite chips or cement-bentonite grout. For the cement-bentonite grout, a minimum of approximately 3 percent powdered bentonite was added to the grout mixture. Grout was pumped into the borehole using a PVC tremie pipe inside the drill casing. Bentonite chips were poured into the drill casing and hydrated with clean water in approximately 1-foot lifts if no water was present in the borehole. As the grout or chips were placed into the borehole, the drill casing was vibrated and retracted in increments to ensure proper placement of the low permeability materials.

Piezometers were constructed with nominal 2-inch-diameter Schedule 40 PVC flush-threaded casing and screen with 0.020-inch-wide machine slots. Stainless-steel centralizers were fixed to the casing at the top and bottom of the well screen and at approximately every 40 feet along the blank interval of casing. The uppermost centralizer was placed at approximately 10 feet below ground surface (bgs). A Schedule 40 PVC end cap was threaded onto the bottom of the well screen. A 1/16-inch-diameter drain hole was drilled in the bottom of the end cap to facilitate drainage of water from the end cap in the event that the water table fell below the bottom of the piezometer. The filter material consisted of No. 2/12 silica sand. An approximately 0.5- to 1-foot-thick interval of No. 60 transition sand was installed immediately above the filter material to restrict movement of grout into the well screen. The filter material and transition sand were vibrated into place as the drill casing was removed from the borehole. An approximately 3-foot-thick seal consisting of hydrated, medium bentonite chips was placed directly above the transition sand. The remaining annular space was sealed with cement-bentonite grout or medium bentonite chips from the top of the bentonite seal to approximately ground surface. During the installation of all annular well construction materials, the sonic drill casing was vibrated and incrementally raised in a manner that prevented borehole collapse and bridging of annular fill materials. The piezometers were completed at the surface with 8-inch diameter flush-mounted traffic-rated well boxes. The well boxes were surrounded by a 3-foot-square by 6-inch-thick pad constructed with rapid-set concrete reinforced with wire mesh. Each piezometer was fitted with a well cap and locked for security. Although the screen intervals targeted zones that displayed possible signs of water (e.g., staining), it was not possible to develop the piezometers because they either contained insufficient water for development or were dry at the time of completion.

3.4.4 Surveying

The piezometers were surveyed by Summit on November 14, 2012. Elevation was reported in feet above mean sea level (amsl) for the top of the well casing at a measuring point marked on the northern lip of the casing. Summit also calculated the ground surface elevation immediately adjacent to each piezometer by adding the distance between the well casing and the ground surface to the surveyed top of casing elevation. Construction information and the horizontal and vertical coordinates are provided in Table 3-3.

3.4.5 Water-Level Monitoring

On November 12, 2012, AMEC installed Solinst® Levelogger Edge Model 3001 transducers near the bottom of the piezometers. Each transducer is suspended from the piezometer cap by a 1/16-inch-diameter stainless-steel cable.

4.0 DATA SUMMARY

Results for groundwater and surface water monitoring for the 2015 through mid-2016 are discussed in this section. All 2016 data are considered preliminary. Transducer data and flow data for 2015 through mid-2016 are provided on compact disk (CD) in Appendix C. Summary graphs of the data are provided on the CD along with the individual data files for each location. Results for groundwater and surface water monitoring for the 2012, 2013, and 2014 field seasons were presented in previous reports dated March 18, 2014 and March 31, 2015 (Atlantic Richfield 2012b and 2015b).

4.1 QUALITY-CONTROL REVIEW

Following the retrieval of data from the transducers, data are reviewed following the procedures presented in the final RI/FS Quality Assurance Project Plan, Revision No. 1 (Atlantic Richfield, 2016a) to identify potential problems with the transducers and identify whether anomalous measurements are present in the data set. During the review process, data categorized as "unusable" are noted in the final data record and are subsequently not used.

Once the final data record was established, the remaining (i.e., usable) data were corrected for atmospheric pressure (measured by a barometric transducer). The data were then compared to monitoring station construction information to calculate the thickness of water above the transducer, water surface elevation, and flow (for flow measurement stations).

Transducers used in the V-notch weirs for stream gauge measurements are Solinst M5 Leveloggers® with precision of +/- 0.05 percent. At a flow of 1.2 cfs, the highest mean flow calculated in 2016, this is equivalent to precision of approximately +/- 0.0006 cfs.

To control accuracy and reduce system error in flow calculations, transducer is checked periodically in accordance with Standard Operating Procedure 39.0 in final RI/FS Quality Assurance Project Plan, Revision No. 1 (Atlantic Richfield, 2016a). If the difference between a transducer reading and the manually measured depth differs by 5 percent or more, the transducer is repositioned to correspond the manual reading. No flow measurement station has failed this check.

Evaporation Pans were calibrated at least every six months. Meteorological Stations were calibrated annually. NovaLynx Corporation certifies that the meteorological data collection systems were checked and tested using recognized standards. Some of the calibration devices are traceable to the National Institute of Standards and Technology. Work was completed according to the manufacture's calibration procedures and specifications and complies with former MIL-STD-45662A.

The quality of the data used in this report were checked in accordance with the final RI/FS QAPP, Revision No. 1 (Atlantic Richfield, 2016a). The data are considered representative, comparable, and useable for the purposes of completing the objectives of this study.

4.2 PRECIPITATION

Precipitation data in the Upper Tributary watershed exhibit the pattern typical for a Mediterranean climate with most precipitation occurring between October and May. Most precipitation at the site from November through March arrives as snowfall. Summer and fall are generally dry except for localized thunderstorms that may quickly drop large volumes of precipitation. Since September 2011, total daily precipitation at MET-01 has ranged from zero to 1.84 inches (Graph 4-1). Since January 2012, total yearly precipitation has ranged from 3.36 inches (2013) to 14.77 inches (2015).

4.3 STREAM FLOW

Stream flow has been measured at stations SF-01, SF-02, and SF-03 on the Upper Tributary since November 2012 (Graph 4-2). Stream flows discussed in this section are mean daily values. Between April 2013 and March 2016, no mean daily flows approached 0.1 cfs. From November 2012 to May 2016, mean daily flows at stations SF-01, SF-02, and SF-03 were 0.014, 0.013, and 0.015 cubic feet per second (cfs), respectively (equivalent to 6.3, 5.7, and 6.7 gallons per minute [gpm], respectively). Results from 2015 through mid-2016 stream-flow monitoring are discussed below.

4.3.1 2015 Results

Graph 4-3 shows measured mean daily flows at stations SF-01, SF-02, and SF-03 and daily precipitation in 2015. Although increased stream flow was observed after some precipitation events, especially at station SF-03, flows were very small (i.e., hundredths of cfs). No flow was measured at station SF-01 in 2015, and the maximum mean daily flow at station SF-02 was only 0.0036 cfs. Atlantic Richfield defines no flow as any time when the water level detected by the transducer is not above the v-notch elevation. The first measurable precipitation in 2015 occurred on January 27. A larger event on February 7 generated a mean daily stream flow of 0.029 cfs at station SF-03, the highest mean daily flow in 2015. By October, conditions were wetter than they had been in several years, but increased precipitation is not reflected in stream flow because of the subfreezing temperatures. Total precipitation measured at MET-01 in 2015 was 14.77 inches.

4.3.2 2016 Results

Stream flow in the Upper Tributary in 2016 was typically one to two orders of magnitude higher than in 2015, reflecting greater precipitation in late 2015 and early 2016. Total precipitation measured at MET-01 in 2016 through June 1 was 8.74 inches; more than the total for all of 2013 or 2014 (3.36 inches and 8.28 inches, respectively). Graph 4-4 shows measured mean daily flows at stations SF-01, SF-02, and SF-03, along with daily precipitation. Flow at all three stations shows very similar characteristics with maximum mean daily flows of 0.90 cfs, 0.90 cfs, and 1.2 cfs at stations SF-01, SF-02, and SF-03, respectively. Several precipitation events (snowfalls) occurred in January and early February 2016. Flows above 0.4 cfs at station SF-03 occurred on March 20 through 21, April 9 through 11, and May 5 through 8. Similar or lower flows occurred at stations SF-01 and SF-02. The largest flows on the Upper Tributary in 2016 immediately followed large precipitation (presumably rainfall) events rain) on April 10 (0.74 cfs at station SF-03) and May 6 (1.20 cfs at station SF-03).

The Upper Tributary is an ephemeral stream with measured flows occurring primarily in response to rainfall events or snowmelt. Mean annual flows for 2016 were calculated using mean daily flows measured at stations SF-01, SF-2, and SF-03. The resultant mean annual flows in 2016 for stations SF-01, SF-02, and SF-03 in 2016 were 0.11 cfs (49 gpm), 0.093 cfs (42 gpm), and 0.12 cfs (52 gpm) respectively. At most times, flow measured at station SF-01 was higher than at station SF-02. Flow was almost always highest at station SF-03.

4.4 GROUNDWATER

Graphs 4-5 and 4-6 show groundwater elevations in all Upper Tributary piezometers that had water-level fluctuations of at least 0.2 feet and mean daily flows at all three flow measurement stations for 2015 and 2016, respectively. Large differences in groundwater elevations between piezometers (i.e., tens of feet) and variations in stream flow (i.e., zero to 1 cfs) are apparent. Subsequent plots group piezometers with similar water levels. Gaps in plotted data indicate levels below the transducer elevations or problems in data acquisition.

Because of substantial differences in water-level elevations and flow fluctuations between locations, different y-axis scales are used in different plots to best show variations in water levels. Water levels tend to vary by depth and location. Upstream piezometers (e.g., DPZ-01 through DZP-06) exhibit higher water elevation (when they were not dry) than piezometers farther downstream. Piezometers PZ-39 and PZ-47, screened across mine waste and native materials (gravel, clay, and sand) beneath mine waste, have much lower groundwater elevations than any other nearby piezometers. Piezometers PZ-45, PZ- 50, PZ-51, PZ-52, PZ-54, and PZ-55 are screened in shallow mine waste. Piezometers PZ-44 and PZ-53 are screened in native materials below the mine waste, and piezometer PZ-49, is screened in bedrock.

Table 4-1 presents the maximum mean daily change in the height of the water column above the transducer in Upper Tributary piezometers for 2015 and 2016. The screened lithology for each piezometer is also provided. The mean daily height of the water column above the transducer is presented and used to discuss water-level changes in this table because these data provide readily comparable information about water-level changes over the course of the year. In 2015, the maximum change in water height ranged from zero (dry) to 5.73 feet in piezometer PZ-55. In 2016, the maximum change was 7.36 feet in piezometer PZ-39. A more detailed evaluation of water levels is provided in the following sections.

4.4.1 Drive-Point Piezometers

All drive-point piezometers were dry at the time of installation and when the transducers were installed. The drive-point piezometers were installed to measure water levels during wet periods like spring melts. The drive-point piezometers in the Upper Tributary area indicate water levels from depths of less than 5 feet bgs (Table 4-1).

4.4.1.2 2015 Results

In 2015, water levels in most drive-point piezometers were never more than a few tenths of a foot above the transducer. Maximum changes in mean daily water levels ranged from zero to 0.46 feet (Table 4-1). Drive-point piezometers DPZ-01, DPZ-03, and DPZ-05 were dry, and DZP-02 was nearly dry. Mean daily water levels in drive-point piezometers DPZ-04 and DPZ-06 fluctuated within a few tenths of a foot around 7,039 and 7,038 feet amsl, respectively (Graph 4-7). As shown on Graph 4-7, mean daily stream flow at station SF-02 at the time of water-level measurements was in most cases negligible; however, stream flow infrequently occurred over short time periods in response to rainfall events or snowmelt in April, May, and June 2015. The maximum mean daily stream flow at station SF-02 during this time period was 0.0036 cfs.

4.4.1.3 2016 Results

After the relatively wet winter of 2015/2016, water levels in the drive-point piezometers had changed little from 2015 (Graph 4-6). No water-level data were collected from drive-point piezometer DPZ-05 because of a malfunctioning transducer. The mean water level in drive-point piezometer DPZ-04 was only 0.01 feet higher than the mean for 2015, and the mean level in drive-point piezometer DPZ-06 was the same as in 2015. In 2016, maximum mean daily water-level change was 0.68 feet (Table 4-1). Drive-point piezometer DPZ-02 was dry for most of the year, but had more than 0.30 feet of water for a few hours during the precipitation event on May 6, 2016. Maximum mean daily water-level changes in drive-point piezometers DPZ-01 and DZP-03 were 0.30 and 0.66 feet respectively. Water levels in drive-point piezometers DPZ-01 fluctuated around 7,057 feet amsl, and around 7,053.5 feet amsl in drive-point piezometer DPZ-03 after rising about six tenths of a foot over two days in February 2016 (Graph 4-8). As shown on Graph 4-8, stream flow at station SF-02 during the time of water-level measurements fluctuated in response to rainfall events or snowmelt in March through May 2016. The maximum mean daily flow at station SF-02 during this time period was more than 0.90 cfs in May.

Mean daily water levels in drive-point piezometers DPZ-04 and DPZ-06, with maximum changes in heights of 0.68 feet and 0.49 feet (Table 4-1), fluctuated within a few tenths of a foot around 7,039 feet and 7,038 feet amsl, respectively (Graph 4-9). These levels are similar to water levels measured during 2015. Drive-point piezometer DPZ-04 reached a maximum height of 0.68 feet above the transducer in 2016.

4.4.2 Piezometers

Standard (non-drive-point) Upper Tributary piezometers can generally be divided into three depth categories: shallow with screens in the range of 7 to 21 feet bgs (PZ-45, PZ-52, PZ-54, and PZ-55); intermediate with screens in the interval of 21 to 37 feet bgs (PZ-44, PZ-49, PZ-50, PZ-51, and PZ-53); and deep with screens at depths of 87 to 108 feet bgs (PZ-39 and PZ-47)

(Table 4-1). Mean daily water levels measured in all piezometers from 2015 through mid-2016 are discussed below. Water levels discussed in this section are mean daily values.

4.4.2.2 2015 Results

Groundwater was present in all Upper Tributary piezometers in 2015 with the exception of piezometer PZ-51 (Table 4-1). Total water-level fluctuations in piezometers PZ-47, PZ-49, and PZ-52 were less than 0.1 feet. Graph 4-10 (showing piezometer PZ-49) is an example of the water-level fluctuations observed in these nearly dry piezometers. Graph 4-10 shows many minor fluctuations that may be indicative of atmospheric pressure changes and signal noise rather than actual water-level variations. Only two piezometers, PZ-39 and PZ-55, had water-level changes greater than one foot in 2015.

Water levels in piezometer PZ-55, located more than 300 feet downstream from station SF-02, reached a height of 5.73 feet above the transducer in 2015, more than any other piezometer, with maximum elevations of approximately 7025.3 feet and 7023.7 feet amsl in February and June 2015 (Graph 4-11). Stream flow for stations SF-01 and SF-02 were not plotted on Graph 4-11 because stream flow was insignificant.

Water levels in deep-screened piezometer PZ-39 (west of the Upper Tributary) increased erratically in 2015 from the beginning of the year until late June, reaching a maximum elevation of 6950.08 feet amsl on June 23 (Graph 4-12) for a total change of about 1.1 feet for the year. From this peak in June, water levels dropped steadily until December.

4.4.2.3 2016 Results

Groundwater was measured in all Upper Tributary piezometers in 2016 with the exceptions of piezometers PZ-51 and PZ-53 (Table 4-1). In general, water-level changes in 2016 were considerably greater than the previous two years. Total water-level variations in piezometers PZ-49, PZ-52, and PZ-54 were less than 0.1 feet. Four piezometers, PZ-39, PZ-45, PZ-47, and PZ-55, had water-level changes of more than one foot.

The groundwater level in piezometer PZ-45 increased rapidly in March to an elevation of 7,032.83 feet amsl before declining (Graph 4-13). Two smaller water-level spikes correlate with increased stream flow, which mirrors precipitation events during those months. This sharp water-level response to precipitation events is possibly related to localized recharge near this piezometer, which appears to be in a possible former ephemeral stream channel based on pre-waste-emplacement topographic data. From 2015 to 2016, the maximum water-level change in piezometer PZ-45 increased from 0.82 to 5.44 feet above the transducer.

Piezometer PZ-55 is screened in shallow mine waste from 6.9 to 21.4 feet bgs (Table 4-1). Between February 4 and February 10 in 2016 the water level in piezometer PZ-55 increased more than 4 feet to an elevation of 7023.91 feet amsl (Graph 4-13). It fluctuated near this level until early May when it began to decline. The maximum change in water levels in piezometer PZ-55 was 4.64 feet, which is less than the 5.73 feet change in 2015.

In piezometers PZ-44 and PZ-50 (north of the Upper Tributary), water levels in 2016 were relatively similar in magnitude (between 7014 and 7016 feet amsl) (Graph 4-14), but show much different fluctuation patterns. While levels in piezometer PZ-50 fluctuated around 7015.5 to 7016.0 feet amsl, water levels in piezometer PZ-44 increased rapidly in May by almost a foot after being stable around 7014.5 to 7014.7 feet amsl until that time. After peaking on May 20, water levels declined to near previous levels by late June. This water-level peak followed the highest stream flows on the Upper Tributary measured in 2016.

Graph 4-15 shows water levels in piezometer PZ-39 (screened in native materials beneath mine waste) and piezometer PZ-47 (screened in deeper mine waste) plotted against cumulative precipitation and stream flow at station SF-02. Water levels increased by up to 7.36 in piezometer PZ-39 and 2.10 feet in piezometer PZ-47 in 2016. Water levels in these deeper piezometers show few of the rapid fluctuations observed in the shallower piezometers. Although available data generally does extend past May 31, the early declines of water levels in these piezometers are more gradual than most of the shallower piezometers.

5.0 DATA ANALYSIS

Until the 2015/2016 wet season, relatively little groundwater level and surface water flow data were available to evaluate because of the dry conditions in previous years. The 2015/2016 wet season data provide an initial, small set of data to evaluate during a near-normal water year. Because this data set is of relatively short duration, there is considerable uncertainty associated with interpretations related to possible long-term groundwater recharge trends based on these data.

The data collected and analyzed for this study were also evaluated for presentation purposes, particularly stream-flow data for graphing. The following is a description of how stream-flow data were presented in this report:

- During high stream-flow periods, water flowed over the tops of the v-notch weirs. Flow rates during these periods could not be calculated because the true, larger stream flow is not possible to calculate when water is flowing over the top of a v-notch. As a result, stream flow when water flowed over the top of a v-notch were plotted on graphs at the maximum calculated flow rate for a particular weir (i.e., the stream flow representing water levels at the top of the v-notch);

- Stream stages were recorded using transducers and data loggers. For periods when no stream flow was occurring (i.e., no water present in the stream, water in the stream was frozen, and possible instrument malfunction) the values were plotted as zero.

5.1 PRECIPITATION

Spring 2016 was the first period to follow a relatively wet winter since 2012 and was the first wet period captured by regular monitoring in the Upper Tributary area. The table below presents total annual precipitation measured at station MET-01 for 2012 through May 31, 2016.

TOTAL ANNUAL PRECIPITATION – STATION MET-01

Year	Total Precipitation (inches)
2012	14.1
2013	3.36
2014	8.28
2015	14.77
2016 (to 5/31)	8.74

The greatest amount of precipitation to fall on a single day since September 2011 was 1.84 inches on February 27, 2014 (Graph 4-1). Although 2012 had almost as much total precipitation as 2015, the 2015/2016 wet season is by far the wettest in the monitored timespan. Most of this precipitation (snowfall) was not available to recharge groundwater or streams until significant melting occurs in April, May, and June.

5.2 PRECIPITATION AND STREAM FLOW

Although many individual precipitation events are evident, there was little runoff in the Upper Tributary from the time monitoring began in late 2012 until spring 2016 (Graph 5-1). Although there was substantially more total precipitation in 2015 than in either of the previous two years, the increased precipitation had little effect on stream flow during 2015. Most precipitation from 2015 summer storms was probably absorbed by the soil, after two years of drought, and precipitation after October was mainly snow. A heavy spring snowmelt and increased precipitation in 2016 significantly increased stream flow and water levels in many, but not all piezometers.

Stream flow in the Upper Tributary was minimal during the drought conditions that prevailed in 2014 and early 2015. The small flows measured in 2015, mostly at station SF-03, were likely due to shallow recharge after precipitation events base on limited correlation (Graph 4-3). This limited correlation between precipitation and stream flow disappeared almost entirely later in the year when drier soil conditions may have absorbed most potential recharge, or when precipitation began to fall as snow. Higher flows at station SF-03 relative to station SF-02 are short lived after precipitation events and may be due to surface runoff (sheet flow) from the hillside to the south into the lined channel portion of the Upper Tributary.

In contrast to 2015, there appears to be a strong relationship between precipitation and stream flow in 2016 once the weather had warmed and snowmelt runoff ceased (Graph 4-4). By May, drier conditions had reduced the correlation between precipitation events and stream flow, possibly because of increased infiltration and related soil moisture retention. During spring recharge (February through April), mean daily temperature correlates closely with stream flow (Graph 5-2), especially during subfreezing conditions.

Total monthly runoff from 2013 through mid-2016, defined as stream-flow discharge in the Upper Tributary at station SF-03, was plotted as a fraction of total monthly precipitation in the Upper Tributary watershed to illustrate the relationship between precipitation and stream flow in the Upper Tributary (Graphs 5-3 through 5-6). Measured monthly stream-flow volume at station SF-03 was converted to inches across the 0.59 square-mile watershed and divided by total precipitation to calculate the percentage of precipitation as runoff. Runoff in 2013, 2014, and 2016 was equal to 26 percent, 16 percent, and 29 percent of the total precipitation in the watershed subbasin. Runoff was a negligible 1 percent of total precipitation in 2015. Only in 2016 was there significant runoff, which ranged from approximately 0.33 to 0.41 inches in March, April, and May, equivalent to mean discharge rates of 75 to 97 gpm. The difference between total precipitation and stream-flow runoff is some combination of evapotranspiration, infiltration, and groundwater recharge.

5.3 STREAM FLOW AND GROUNDWATER

Groundwater in piezometers located near the Upper Tributary or other ephemeral stream channels (e.g., the drainage swale west of Pond 2N) could theoretically receive recharge from those watercourses independent of regional recharge; however, because conditions were dry and flows low, there was generally little or no correlation between stream flow and groundwater levels in 2015. Water levels in the drive-point piezometers also did not appear to correlate to stream flow (Graphs 4-7 and 4-8). The water-level rise in drive-point piezometer DPZ-03 preceded the increase in stream flow and was, therefore, apparently not directly related to stream flow. There do appear to be some possible correlations between stream flow and water levels in drive-point piezometers DPZ-04 and DPZ-06 in 2016 (Graph 4-9), although water levels in drive-point piezometers differed little from those in 2015.

As with the drive-point piezometers, water-level changes in standard piezometers near stream channels showed little correlation with stream flow. The initial water-level rise in piezometer PZ-55 is more likely related to spring recharge than to increased stream flow because there is no correlation with other flow events (Graph 4-11). No water-level correlation with stream flow was evident in other piezometers near the Upper Tributary in 2015 (Graphs 4-11 and 4-12).

After the relatively wetter winter and spring 2016, stream discharge was much greater than in 2015, but water levels in piezometers still generally appear to have little correlation with stream flow (Graphs 4-13 and 4-14). An exception is the flow event that peaked on May 6, which caused modest water-level increases in piezometers PZ-44, PZ-45, and PZ-55. Piezometer PZ-44 had an increase of almost a foot. Piezometer PZ-44 (deeper) and PZ-45 (shallow) are located in a possible former ephemeral stream channel based on on pre-waste-emplacement topographic data, which may provide some volume of surface flow recharge at certain times.

Considering the generally minimal apparent stream-flow recharge, there may have been other factors associated with recharge from the May 6, 2016, storm that magnified water-level changes such as wetter soil conditions preceding the storm. Because stream flow mimics precipitation events (after the spring melt) in 2016, water-level increases in shallower piezometers may be related to areal groundwater recharge as much as stream-flow recharge.

Water levels in the deep-screened piezometers (PZ-39 and PZ-47) had no relationship with surface flow (Graph 4-15), but they are likely driven by seasonal recharge and the effects of long-term groundwater recharge from cumulative precipitation events.

At most times, flow measured at station SF-01 was higher than at station SF-02, and flow was greatest at station SF-03. The differences in flows between stations SF-01 and SF-2 in 2016, with means of 0.109 cfs (49.1 gpm) and 0.093 cfs (41.7 gpm), respectively, suggest a generally losing reach with a mean loss of about 7.3 gpm across this unlined reach. Increased flow at station SF-03, with a mean flow of 0.115 cfs (51.4 gpm), suggest a generally gaining reach with a mean gain of 10 gpm.

5.4 PRECIPITATION AND GROUNDWATER

Little recharge appears to occur in most shallow materials along the Upper Tributary near the drive-point piezometers (Figure 5-7), but with the exception of drive-point piezometer DPZ-02, all of them did receive a relatively small to moderate volume of shallow recharge in 2016, with maximum water-level changes ranging from 0.30 to 0.68 feet. Water at these shallow depths might be considered as shallow recharge or perched groundwater with little apparent connection to deeper groundwater.

Piezometers PZ-49, PZ-51, PZ-52, and PZ-53 have been consistently dry or had very low water levels, even during periods of higher precipitation observed in 2016. Water-level data from these piezometers show that little groundwater is present at mid-depths along the border between Ponds 2N and 2S and the slope to the southwest, except at the mouth of the swale near piezometer PZ-44. Little recharge apparently occurs in this mid-depth zone (based on the water-level responses in the piezometers during a moderately wet year (2016 wet season).

Piezometer PZ-55 had the most significant accumulation of groundwater in both 2015 and 2016 (Graphs 4-11 and 4-13) and water levels appeared to respond strongly to spring recharge. The recovery of water levels in June 2015 corresponds to multiple recharge events over that period (Graph 4-3). Increased water levels in PZ-55 in 2016 appear to correlate with a moderate precipitation event in early March (Figure 5-7), but this is also around the time that significant recharge from the spring thaw would also be occurring.

In 2016, water levels in piezometer PZ-45 increased rapidly in the spring by more than 5 feet (Figure 5-7) before declining erratically, and then rapidly recovering to pre-spring levels by early June presumably in response to several precipitation events. Piezometer PZ-45 is screened in higher transmissivity mine waste materials and appears to be in a possible former ephemeral stream channel based on pre-waste-emplacement topographic data. From 2015 to 2016, the maximum water level in piezometer PZ-45 increased from 0.82 to 5.44 feet above the transducer. Substantially greater water-level increases in piezometer PZ-45 relative to other piezometers along the southwest margin of Ponds 2N and 2S is possibly related to higher transmissivity materials associated with a higher gravel content of mine waste in the lower part of the screen interval for piezometer PZ-45 and localized groundwater recharge associated with its location within the possible former ephemeral stream channel.

The relatively deeper-screened piezometers PZ-39 and PZ-47 exhibited a longer, larger, and smoother response to seasonal recharge than did other, shallower piezometers (Graphs 4-12 and 4-15). Water levels in piezometer PZ-39 increased much more in 2016 than in 2015. Piezometer PZ-47 was virtually dry in 2014 and 2015. The first substantial water-level increase (about 3 feet) in piezometer PZ-47 began in late May 2016. Water levels in these piezometers appear to be independent of stream flow or individual precipitation events and may be related to deeper, seasonal groundwater recharge and, in warmer weather, the cumulative influence of precipitation events.

Although piezometers generally had significantly higher water levels in 2016 than in previous years, piezometers do not have sufficient horizontal distribution to contour the potentiometric surface in this area because they are mostly located in a line along the base of the slope to the southwest. Water levels from shallow drive-point piezometers are thought to represent shallow infiltration and should not be contoured with deeper piezometers that represent the groundwater regime in the Upper Tributary area. The deep piezometers PZ-39 and PZ-47, have screen intervals below mine waste and should not be contoured with the mid-depth piezometer data. Of the remaining piezometers with usable water levels, piezometers PZ-44, PZ-45, PZ-50, and PZ-55 are essentially located in a line along the western edge of mine waste beneath Ponds 2N and 2S. The locations of these piezometers are strongly constrained by topography and the pond footprints.

6.0 CONCEPTUAL HYDROLOGIC UNDERSTANDING FOR THE UPPER TRIBUTARY AREA

The following interpretations are based on precipitation, stream flow, and groundwater-level data collected on the Upper Tributary and around Ponds 2N and 2S.

- Stream flow is primarily dominated by spring snowmelt runoff and there is little groundwater recharge or baseflow at least in the lower portion of the Upper Tributary. During dry years (e.g., 2015), summer storms generally have little impact on stream flow in the Upper Tributary area of the site; many summer storms produced little or no measureable stream flow. The impact of summer storms on stream flow is much greater after a wet winter such as in 2016.
- There is relatively little groundwater or groundwater recharge along the Upper Tributary. Water-level increases in shallow drive-point piezometer were not much different in 2016, after a relatively wetter winter, than in 2015, a very dry year until fall. Shallow groundwater in drive-point piezometers may be more closely related to shallow infiltration and localized saturated conditions than to the deeper and more continuous groundwater flow regime measured by conventional piezometers.
- A connection between stream flow and groundwater levels is generally weak or absent. There appears to be generally very limited groundwater recharge from the Upper Tributary. Other than during spring runoff, when flow increases significantly downstream because of surface runoff, the creek is not strongly gaining or losing in the lower reach near the piezometers. The reach between stations SF-01 and SF-02 is generally a losing reach, with a mean loss of approximately 7.3 gpm. The reach between stations SF-2 and SF-03 is a gaining reach with a mean gain of approximately 10 gpm.
- As described above, shallow groundwater in drive-point piezometers may be more closely related to shallow infiltration and localized saturated conditions than to the deeper and more continuous groundwater flow regime measured using conventional piezometers. Groundwater levels measured in conventional piezometers appear to

be more strongly influenced by seasonal recharge than shallow groundwater as measured in drive-point piezometers. Many, but not all, conventional piezometers had substantially higher groundwater levels in 2016 than previous years. Cumulative summer storms also appeared to influence groundwater levels after a relatively wetter winter when soil moisture was likely higher than in previous years.

- Water levels in deep piezometers PZ-39 and PZ-47 increased substantially for the first time in the water year 2015/2016. This increase appears to be related to seasonal recharge and cumulative precipitation recharge, and unrelated to individual precipitation events. In normal or wetter water years, limited amounts of groundwater may migrate through shallow mine waste with the potential to interact with mine waste beneath Ponds 2N and 2S.

7.0 SUMMARY CONCLUSIONS

The following broad conclusions summarize results and interpretations (based on precipitation, stream flow, and groundwater-level data from the Upper Tributary) and attempt to answer the questions posed concerning treatability study objectives in Section 2.0

Monitoring data collected in the Upper Tributary area before 2016 are of limited use for meeting the study objectives outlined in Section 2.0 because so little flows occurred prior to 2016 and water-level conditions were in many locations too low to collect reliable information on temporal changes in groundwater levels and develop a broader understanding of groundwater flow conditions in the Upper Tributary area. The current dataset through mid-2016 provides a more useful dataset but is of relatively short duration; however, a few relationships are evident as listed below.

- Stream flow is controlled primarily by seasonal recharge from snowmelt and to a lesser extent by summer storms, especially after a wet spring.
- Groundwater is not strongly connected to stream flow.
- There is relatively little shallow groundwater presence even during a wet spring as indicated by water-level measurements in drive-point piezometers. Groundwater levels in conventional piezometers screened in the deeper more continuous groundwater flow regime are more strongly recharged by spring snowmelt where surface conditions (e.g., topography and soil characteristics) are conducive to infiltration.
- Data are not sufficient to quantify dissolved metals flux into downgradient groundwater, the Upper Tributary, or Leviathan Creek.
- Existing data are not sufficient to estimate groundwater flux from the Upper Tributary watershed with a reasonable degree of certainty.

Results specific to the treatability study objectives outlined in Section 2.0 are presented below.

- What volume of surface water enters the subsurface at the mine site year-round through the Upper Tributary?

  The volume of surface water that may enter the subsurface is complex and location related. Mean stream-flow losses (when the stream is flowing) between flow measurement stations SF-01 and SF-02 are about 7 gpm in 2016. However, mean stream-flow gains between station SF-02 and SF-03 are about 10 gpm. If all the losses between stations SF-01 and SF-02 contribute to the gains between stations SF-02 and SF-03, there is no apparent net stream recharge to the aquifer and an apparent mean net loss of about 3 gpm. However, not all of the stream loss between stations SF-01 and SF-02 necessarily contributes to the gains between stations SF-02 and SF-03, so there may have been some stream recharge to the aquifer within a range of 0 to 7 gpm based on mean streamflow measurements collected through May 31, 2016.

- What volume of surface water is lost or gained upstream of the concrete-lined Upper Tributary channel?

  As stated above, mean 2016 stream-flow gains between stations SF-02 and SF-3 are about 10 gpm, making it a gaining reach for all measurements after March 6.

- What volume of water, if any, leaks out or leaks into the concrete-lined Upper Tributary channel?

  An unknown portion of stream-flow gains between stations SF-02 and SF-03 may be caused by sheet flow/surface runoff during the spring melt. If this amount was zero, then the entire mean gain of 10 gpm in this reach would be leaking through the concrete liner into the stream channel.

- What volume of non-impacted surface water flows through the concrete-lined Upper Tributary channel and is discharged to Leviathan Creek?

  Mean measured flow at station SF-03 is near the end of the concrete-lined channel at the confluence with Leviathan Creek. Mean daily flows were approximately 0.115 cfs (51.4 gpm) in 2016 although mean daily flow ranged from zero to around 1 cfs (450 gpm).

- What is the nature and magnitude of surface water/groundwater interaction in the Upper Tributary where it contacts mine waste beneath Ponds 2S and 2N?

  Two conventional piezometers are screened across the mine waste/native soil contact: PZ-39 and PZ-47. In 2016 groundwater levels in piezometer PZ-39 rose more than 7 feet and for the first time, more than 2 feet in piezometer PZ-47. Groundwater-level changes in these deeper piezometers appear to be driven by regional, spring recharge from snowmelt, and cumulative recharge events (e.g., several summer storms closely spaced in time) with little connection to individual precipitation events.

- Is groundwater flowing at the mine waste/native materials interface beneath Ponds 2S and 2N?

As described above, there was groundwater recharge along the mine waste/native soil interface in 2016 implying that there is groundwater flow at the interface. There were also increases in groundwater levels in several piezometers screened only in mine waste (i.e., PZ-45, PZ-50, PZ-54, and PZ-55), indicating groundwater recharge and/or flow through mine waste. Except for piezometer PZ-55, these changes were less than 1 foot.

- If there is no interfacial flow, what are the possible sources of groundwater entering surface water or groundwater within or adjacent to Leviathan Creek from the Upper Tributary watershed?

  Groundwater levels in piezometer PZ-39 and PZ-47 are 60 feet or more below water levels in other piezometers along Leviathan Creek. Given this amount of hydraulic separation, it seems highly unlikely that this deeper groundwater is discharging to Leviathan Creek. Shallow groundwater as measured in drive-point piezometers is presumed to be the source of water entering the concrete-lined channel between stations SF-02 and SF-03 along with possible surficial (sheet) flow during spring snowmelt.

- If groundwater is flowing at the interface, can it be feasibly controlled and/or intercepted?

  Based on water-level responses in piezometers screened across the interface between mine waste and native materials, groundwater is presumably within the mine waste and/or the native materials. In the 2015-2016 wet season, the relatively greater amount of precipitation apparently contributed to increased infiltration into mine waste within a few of the piezometers in the Upper Tributary area. The volume of water moving through mine waste and the total volume of groundwater flowing from the Upper Tributary watershed to the west toward the Leviathan Creek study area is not currently quantifiable given the relatively short duration of reliable water-level measurements in this area. Additional monitoring data from periods of higher precipitation such as those observed in 2015-2016 would provide longer-term water-level data allowing for estimation of hydraulic gradients and the calculation of groundwater fluxes.

8.0 RECOMMENDATIONS

Atlantic Richfield makes the following recommendations:

- Continue monitoring water levels and stream flow in the vicinity of the Upper Tributary to obtain data under wetter conditions or consecutive wetter years if possible.

- Incorporate reporting of monitoring data collected in the Upper Tributary area into future submittals of the Groundwater Water Technical Data Summary Report and eliminate preparing a separate report. The Groundwater Technical Data Summary Report will provide a more comprehensive presentation of the conceptual model of groundwater flow at the site including a broader evaluation of surface water and groundwater interaction.

10.0 REFERENCES

Atlantic Richfield Company (Atlantic Richfield), 2012a, Additional Characterization of the Upper Tributary Area, On-Property Focused Remedial Investigation Work Plan Amendment No. 2, Leviathan Mine Site, Alpine County, California, Administrative Order for Remedial Investigation and Feasibility Study, CERCLA Docket No. 2008-18. August 3.

Atlantic Richfield Company (Atlantic Richfield), 2012b, 2011 Remedial Investigation/Feasibility Study Data Summary Report Leviathan Mine Site, Alpine County, California. Prepared by Amec Environment and Infrastructure, Inc., August 3.

Atlantic Richfield, 2015a, Optimization of Select On-Property Monitoring Programs, Leviathan Mine Site, Alpine County, California. February 4.

Atlantic Richfield Company (Atlantic Richfield), 2015b, Interim 2012-2013 Report for Upper Tributary Area, Revision No. 2 Subsurface Flow Barrier Treatability Study Leviathan Mine Site, Alpine County, California. Prepared by Amec Environment & Infrastructure, March 31.

Atlantic Richfield Company (Atlantic Richfield), 2016a, Remedial Investigation/Feasibility Study Quality Assurance Project Plan, Revision No. 1, Leviathan Mine Site, Alpine County, California. Prepared by Amec Foster Wheeler, June 17 [Final].

Atlantic Richfield Company (Atlantic Richfield), 2016b, Current Conditions and Reporting Extension Request for Upper Tributary Area Subsurface Flow Barrier Treatability Study, Leviathan Mine Site, Alpine County, California. July 14.

Lahontan Regional Water Quality Control Board (LRWQCB), 2013, Year-End Report for the 2012 Field Season at Leviathan Mine. January 10.

U.S. Environmental Protection Agency (U.S. EPA), 2015), EPA comments on the Atlantic Richfield Submittal of the Interim 2012-2013 Report for Upper Tributary Area, Revision No. 2, Subsurface Flow Barrier Treatability Study, Leviathan Mine Site, Alpine County, California, dated March 31, 2015. September 14.

U.S. Environmental Protection Agency (U.S. EPA), 2016, Atlantic Richfield Response to Comments on the Interim Report for Upper Tributary Area, Revision No. 2, Subsurface Flow Barrier Treatability Study, Leviathan Mine Site, Alpine County, California, Dated November 20, 2015. March 21.

amec foster wheeler

TABLES

TABLE 3-1
SURFACE WATER FLOW MEASUREMENT STATION ELEVATIONS
Leviathan Mine Site
Alpine County, California

Flow Station ID[1]	Northing[2] (feet)	Easting[2] (feet)	Top of Weir Plate Elevation[3] (fmsl)	Bottom of V-Notch Elevation[3] (fmsl)
SF-01	2025907.20	7228716.31	7053.01	7052.01
SF-02	2025979.86	7228756.50	7040.63	7039.63
SF-03	2026581.24	7229603.73	7036.12	7035.12

Note(s)
1. Locations shown on Figure 3-1
2. Horizontal coordinates were surveyed by AMEC and reference NAD83.
3. Elevation surveyed by Summit and reference NGVD29.

Abbreviation(s)
fmsl = feet above mean sea level
NAD83 = North American Datum of 1983
NGVD29 = National Geodetic Vertical Datum of 1929
Summit = Summit Engineering Corporation

TABLE 3-2
DRIVE-POINT PIEZOMETER CONSTRUCTION DETAILS
Leviathan Mine Site
Alpine County, California

Drive Point Piezometer ID[1]	Date Installed	Total Depth (ft btoc)	Total Depth (ft bgs)	Stick up (ft ags)	Casing Diameter (inches)	Screen Diameter (inches)	Depth to Top of Screen (ft bgs)	Depth To Bottom of Screen (ft bgs)	Screen Length (feet)	Depth to Transducer Sensor (ft btoc)	Depth to Transducer Sensor (ft bgs)	Northing[2] (feet)	Easting[2] (feet)	TOC Elevation[2] (ft msl)
DPZ-01	10/26/2012	6.8	2.9	4.0	1	0.75	2.4	2.9	0.5	6.0	2.1	2025884.39	7228693.19	7062.99
DPZ-02	10/31/2012	6.8	1.6	5.2[3]	1	0.75	1.1	1.6	0.5	6.1	0.8	2025889.70	7228691.82	7063.55
DPZ-03	10/25/2012	6.7	1.7	5.0	1	0.75	1.2	1.7	0.5	6.1	1.1	2025894.15	7228707.15	7059.16
DPZ-04	10/25/2012	6.9	3.9	3.0	1	0.75	3.4	3.9	0.5	6.1	3.1	2025964.94	7228746.48	7045.12
DPZ-05	10/25/2012	3.8	2.3	1.5	1	0.75	1.8	2.3	0.5	3.1	1.5	2025968.81	7228742.75	7043.98
DPZ-06	10/25/2012	6.8	4.8	2.0	1	0.75	4.3	4.8	0.5	6.1	4.1	2025969.32	7228749.86	7044.04

Note(s)
1. Locations shown on Figure 3-1.
2. Horizontal coordinates and elevations were surveyed by Summit and reference NAD83 and NGVD29, respectively.
3. Measurement is approximate.

Abbreviation(s)
ft msl = feet above mean sea level
ft ags = feet above ground surface
ft bgs = feet below ground surface
ft btoc = feet below top of casing
NAD83 = North American Datum of 1983
NGVD29 = National Geodetic Vertical Datum of 1929
Summit = Summit Engineering Corporation
TOC = top of casing

TABLE 3-3
PIEZOMETER CONSTRUCTION DETAILS
Leviathan Mine Site
Alpine County, California

Boring ID	Piezometer ID[1]	Date Piezometer Completed	Boring Total Depth (ft bgs)	Boring Diameter (inches)	Piezometer Total Depth (ft bgs)[2]	Piezometer Diameter (inches)	Depth to Top of Screen (ft bgs)	Depth To Bottom of Screen (ft bgs)	Screen Length (feet)	Depth to Top of Filter Pack (ft bgs)	Depth To Bottom of Filter Pack (ft bgs)	Filter Pack Length (feet)	Northing[3] (feet)	Easting[3] (feet)	TOC Elevation[3] (fmsl)	Ground Surface Elevation[3] (fmsl)	Transducer Elevation (fmsl)
B-39	PZ-39	10/14/2011	128.0	6	108.3	2	103.2	107.8	4.60	100.3	108.8	8.5	2026449.74	7228803.51	7040.79	7041.02	6940.79
B-65	PZ-44	9/28/2012	45.0	6	26.6	2	21.5	26.0	4.48	21.0	26.5	5.5	2026608.33	7228363.51	7040.76	7041.14	7014.46
B-65S	PZ-45	10/2/2012	25.0	6	13.9	2	8.9	13.4	4.50	6.9	14.5	7.6	2026617.07	7228354.98	7040.79	7041.10	7027.39
B-67	PZ-47	10/15/2012	141.0	6	97.0	2	87.0	96.6	9.54	84.0	97.0	13.0	2026782.46	7228641.14	7040.95	7041.42	6945.67
B-63	PZ-49	10/18/2012	38.0	6	37.8	2	32.8	37.3	4.50	31.0	38.0	7.0	2026329.16	7228617.19	7041.09	7041.37	7003.89
B-63S	PZ-50	10/19/2012	28.5	6	26.2	2	21.1	25.7	4.60	19.0	26.9	7.9	2026337.86	7228614.49	7041.07	7041.32	7015.47
B-61	PZ-51	10/19/2012	38.5	6	27.1	2	22.1	26.6	4.50	20.0	28.2	8.2	2026037.03	7228802.34	7040.83	7041.22	7014.43
B-62	PZ-52	10/26/2012	22.5	6	12.1	2	7.1	11.6	4.52	5.0	13.0	8.0	2026174.67	7228713.15	7041.13	7041.44	7029.63
B-64	PZ-53	10/26/2012	38.0	6	34.7	2	29.7	34.2	4.50	27.5	35.5	8.0	2026555.98	7228433.12	7040.81	7041.11	7006.61
B-64S	PZ-54	10/29/2012	23.0	6	20.6	2	10.6	20.1	9.50	8.0	21.0	13.0	2026560.75	7228425.60	7040.75	7041.12	7020.75
B-66	PZ-55	10/30/2012	27.5	6	22.0	2	6.9	21.4	14.53	5.1	22.0	16.9	2026248.01	7229014.65	7041.05	7041.27	7019.55

Note(s)
1. Locations shown on Figure 3-1
2. Measurements relative to ground surface predate construction of surface completion and are not surveyed.
3. Horizontal coordinates and elevations were surveyed by Summit and reference NAD83 and NGVD29, respectively.
4. Elevations were surveyed by Summit and reference NGVD29.

Abbreviation(s)
ft bgs = feet below ground surface
fmsl = feet above mean sea level (NGVD29)
NAD83 = North American Datum of 1983
NGVD29 = National Geodetic Vertical Datum of 1929
Summit = Summit Engineering Corporation
TOC = top of casing

amec foster wheeler

TABLE 4-1
MAXIMUM WATER-LEVEL CHANGES IN 2015 AND 2016
Leviathan Mine Site
Alpine County, California

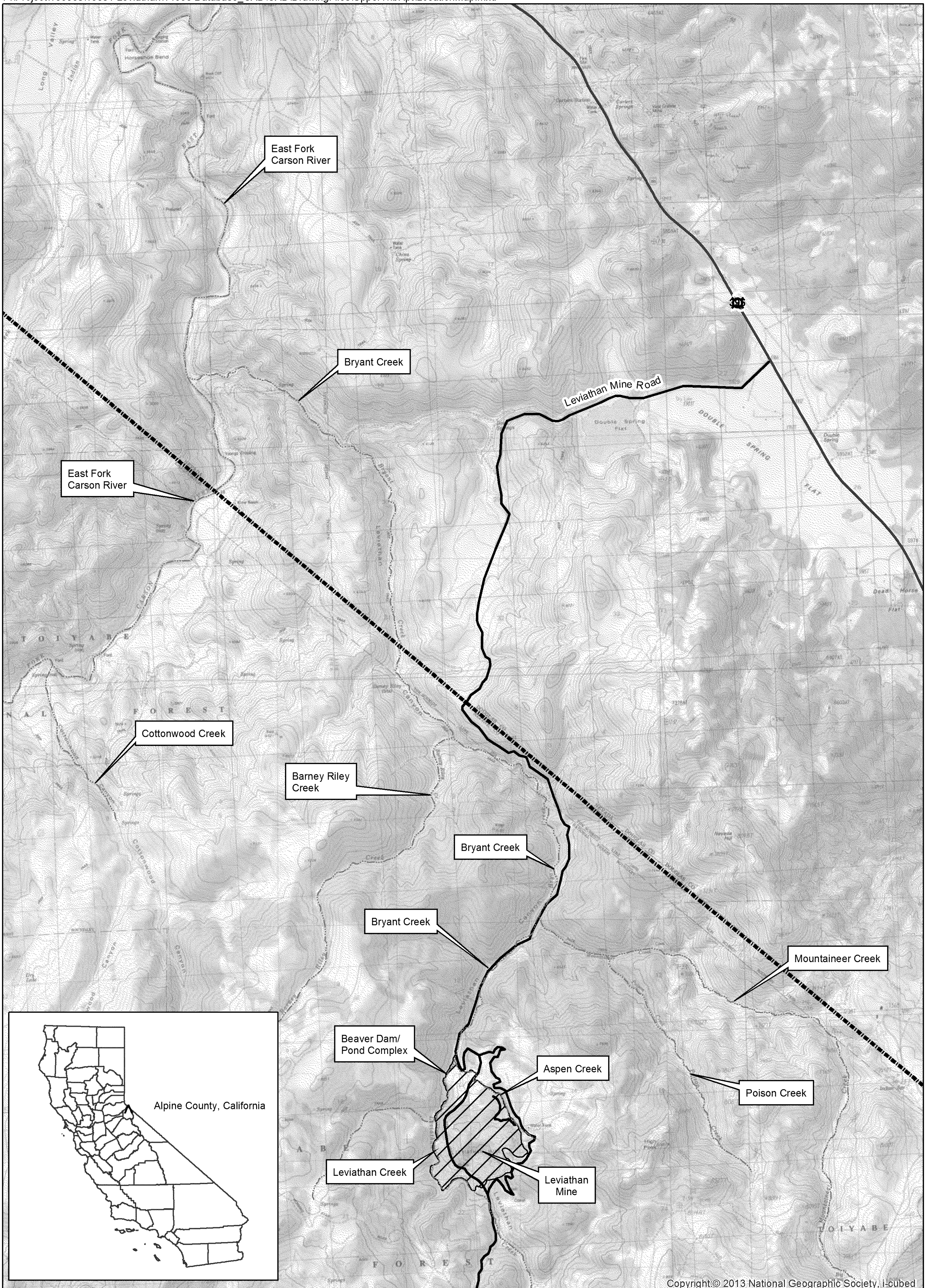
Piezometer	Total Depth (ft bgs)	Depth to Top of Screen (ft bgs)	Depth To Bottom of Screen (ft bgs)	Screen Length (feet)	Screened Lithology	Maximum Mean Daily Water-Level Change[1] (feet)	
						2015	2016
DPZ-01	2.9	2.4	2.9	0.5	NS	dry	0.30
DPZ-02	1.6	1.1	1.6	0.5	NS	0.13	0.22
DPZ-03	1.7	1.2	1.7	0.5	NS	dry	0.66
DPZ-04	3.9	3.4	3.9	0.5	NS	0.46	0.68
DPZ-05	2.3	1.8	2.3	0.5	NS	dry	NA
DPZ-06	4.8	4.3	4.8	0.5	NS	0.42	0.49
PZ-39	128.0	103.2	107.8	4.6	MW/NS	1.10	7.36
PZ-44	45.0	21.5	26.0	4.48	NS	0.49	0.99
PZ-45	25.0	8.9	13.4	4.50	MW	0.82	5.44
PZ-47	141.0	87.0	96.6	9.54	MW/NS	0.03	2.10
PZ-49	38.0	32.8	37.3	4.50	BR	0.08	0.06
PZ-50	28.5	21.1	25.7	4.60	MW	0.36	0.48
PZ-51	38.5	22.1	26.6	4.50	MW	dry	dry
PZ-52	22.5	7.1	11.6	4.52	MW	0.07	0.09
PZ-53	38.0	29.7	34.2	4.50	CO	0.34	dry
PZ-54	23.0	10.6	20.1	9.50	MW	0.30	0.07
PZ-55	27.5	6.9	21.4	14.53	MW	5.73	4.64

Note(s)
1. Maximum mean daily change in water height above transducer during the year.

Abbreviation(s)
ft bgs = feet below ground surface
BR = bedrock
CO = colluvium
MW = mine waste
NA = not available (transducer not working)
NS = native soil (gravel, clay, sand)

FIGURES

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\UpperTribRpt\LocationMap.mxd



Explanation

- Stream Flowlines
- On-Property Study Area
- State Line

Note:
1. National Hydrography Dataset Flowlines are stream thalweg delineations provided by the USGS.

0 2,000 4,000 Feet

LOCATION MAP
Leviathan Mine Site
Alpine County, California

amec foster wheeler

By: DPV
Date: 10/26/2016

Project No. 0013091

Figure
1-1

Path: P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\UpperTribRpt\SiteFeatures.mxd 10/26/2016

Explanation

- Creek
- Study Areas
- Leviathan Creek Basin Landslide
- Approximate Extent of Beaver Dam/Pond Complex (August 2014)

0 300 600 Feet

Notes:
1. All locations and boundaries are approximate.
2. Base map from aerial photograph dated October 22, 2009.

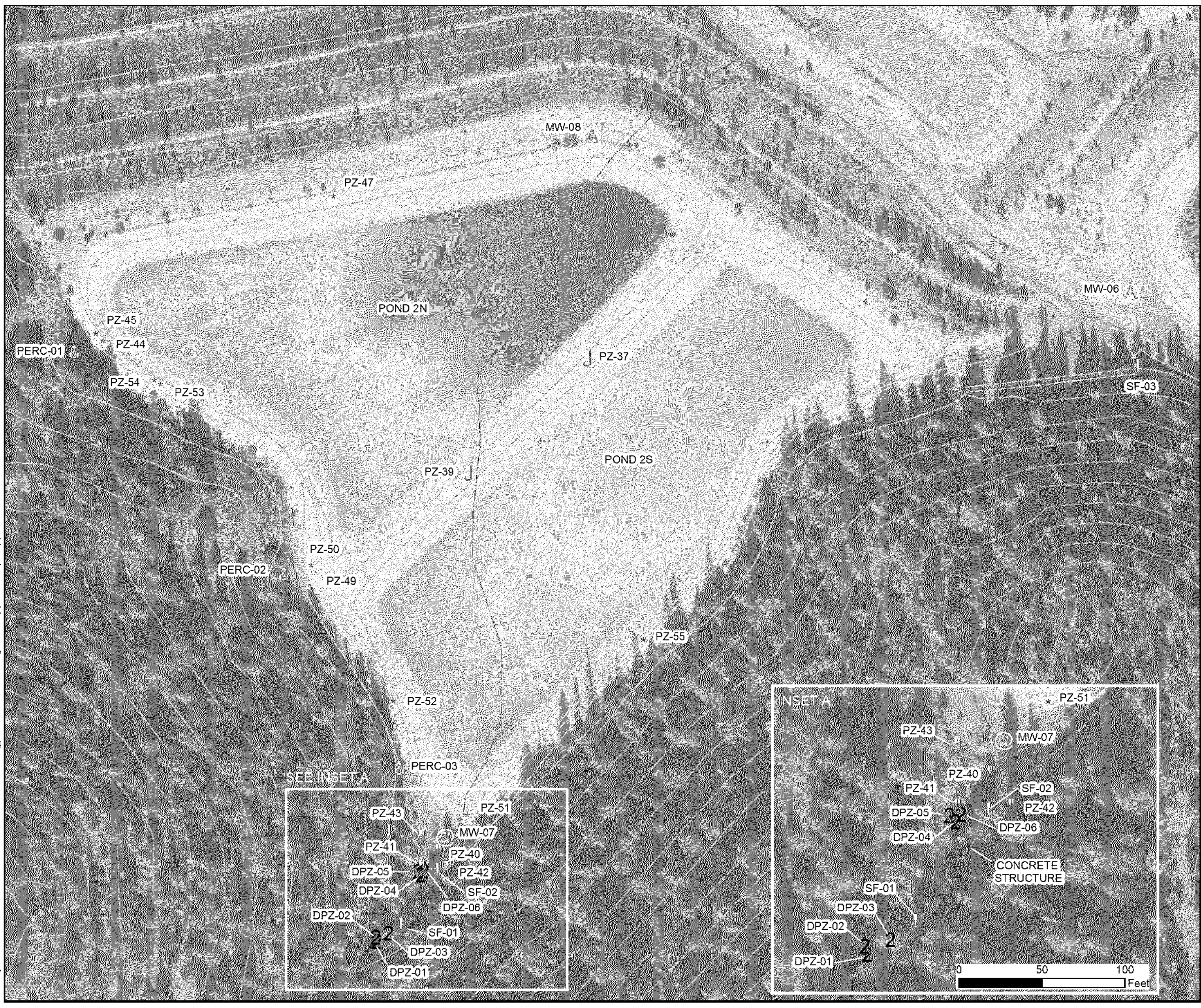
SITE FEATURES
Leviathan Mine Site
Alpine County, California

amec foster wheeler

By: DPV
Date: 10/26/2016

Project No. 0013091

Figure 1-2



Explanation:

- Piezometer (installed in 2012)
- Drive Point Piezometer (installed in 2012)
- Percolation Test Location (performed in 2012)
- Surface Water Flow Measurement Station (installation 2012)
- Existing Monitoring Wells
- Existing Piezometers
- Current Upper Tributary
- Former Tributary (approximate)

Notes:

1. All locations and boundaries are approximate.
2. SF-03 is an existing station. Instrumentation added in 2012.
3. Base map from aerial photograph dated October 22, 2009.

0 60 120
Feet

MONITORING LOCATIONS AT THE UPPER TRIBUTARY AREA
Leviathan Mine Site
Alpine County, California

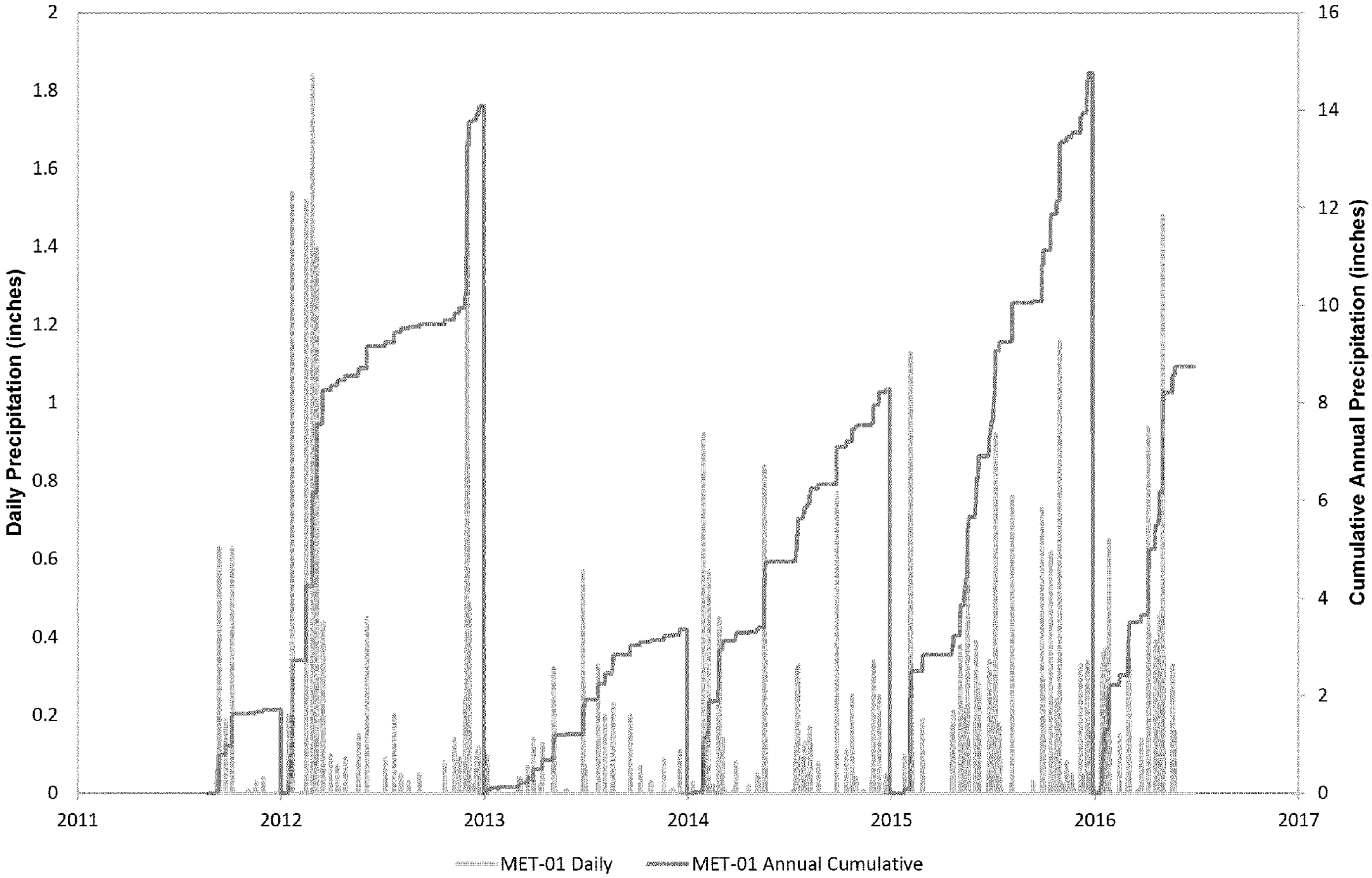
amec foster wheeler

By: DPV Date: 10/26/2016	Project No. 0013091	Figure 3-1

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\UpperTribRpt\UpperTribMonLocs.mxd

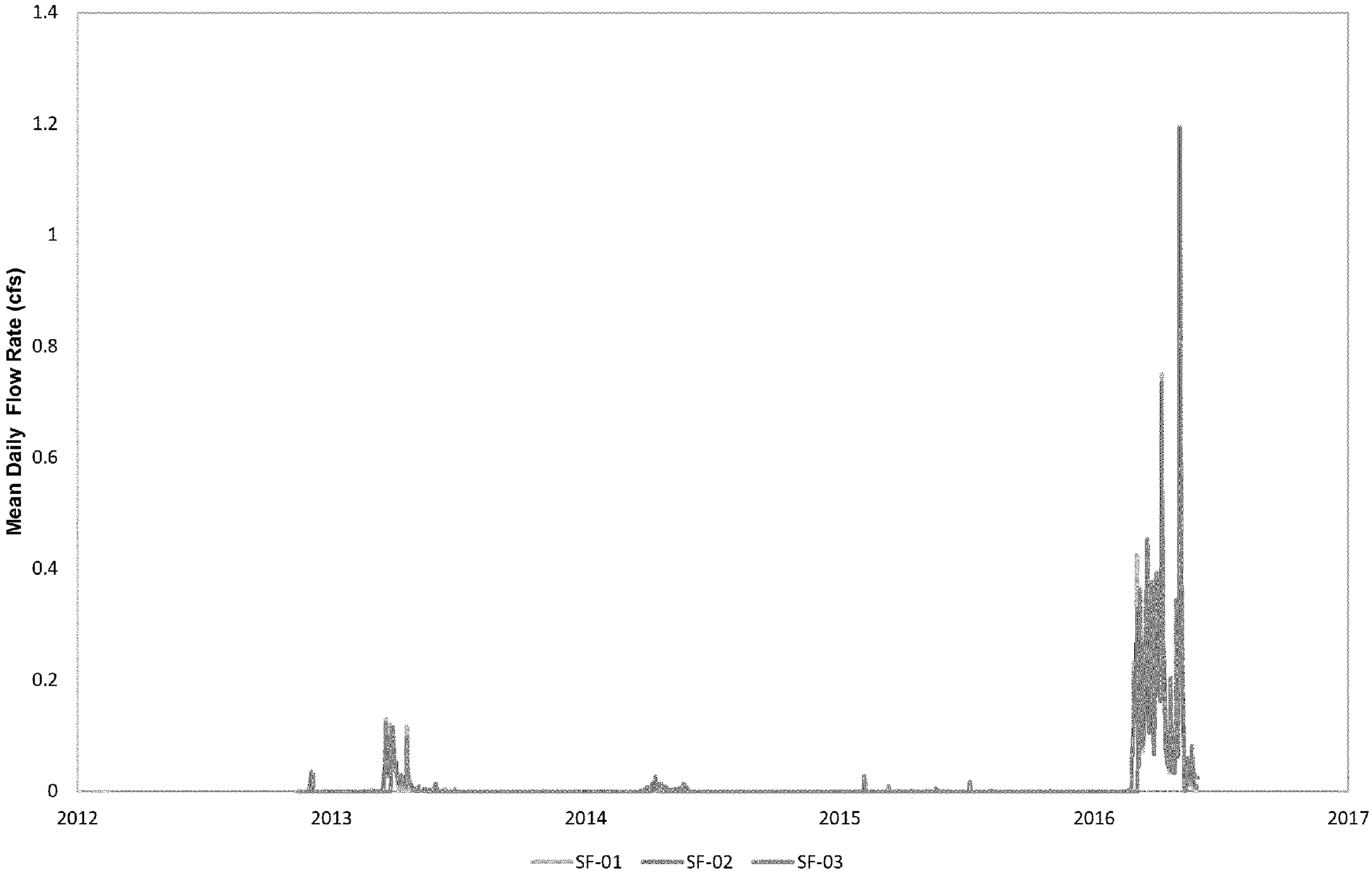
GRAPHS

GRAPH 4-1
LOCAL PRECIPITATION
Leviathan Mine Site
Alpine County, California



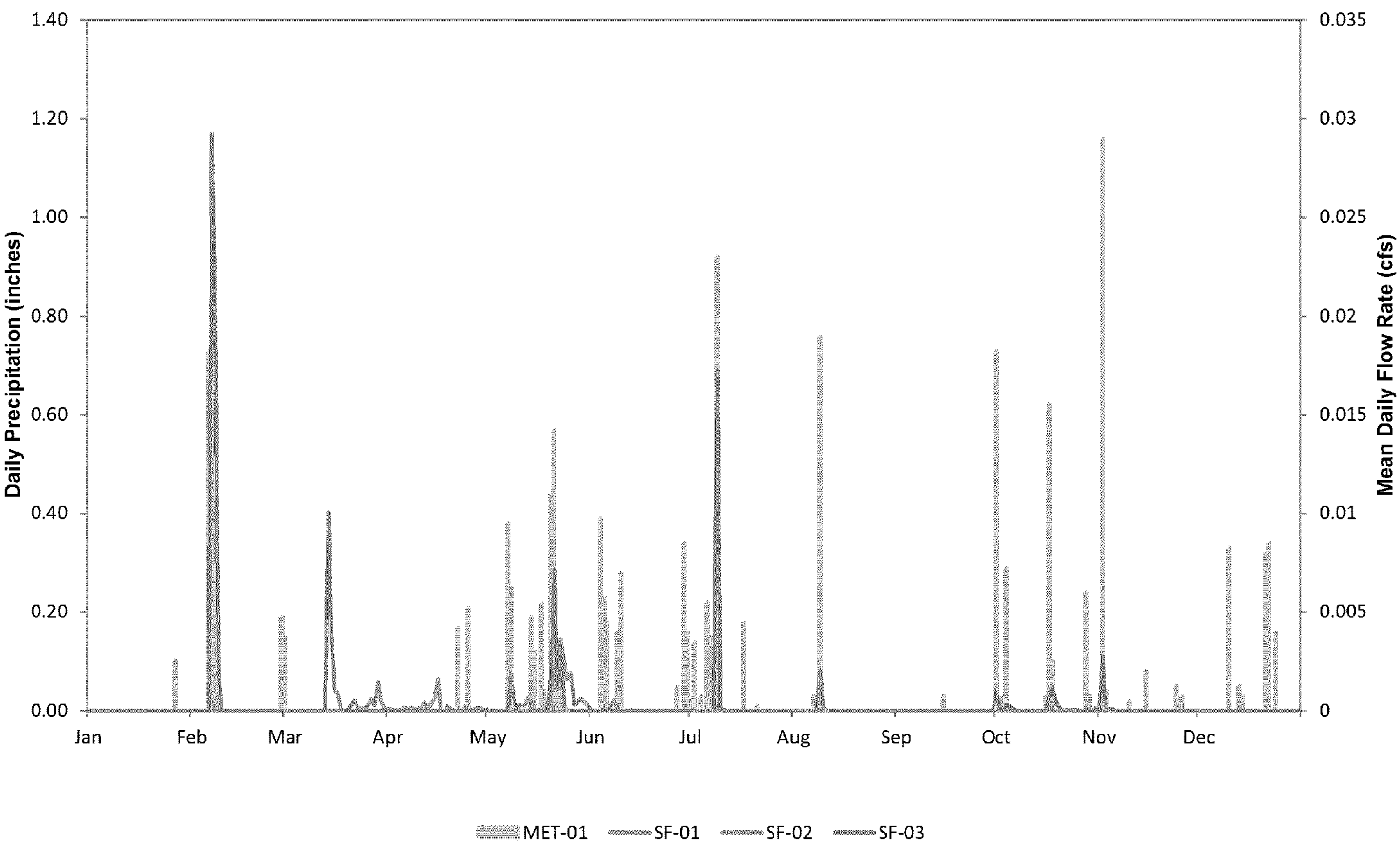
ED_001709_00000302-00041

GRAPH 4-2
FLOW RATES ON THE UPPER TRIBUTARY
Leviathan Mine Site
Alpine County, California



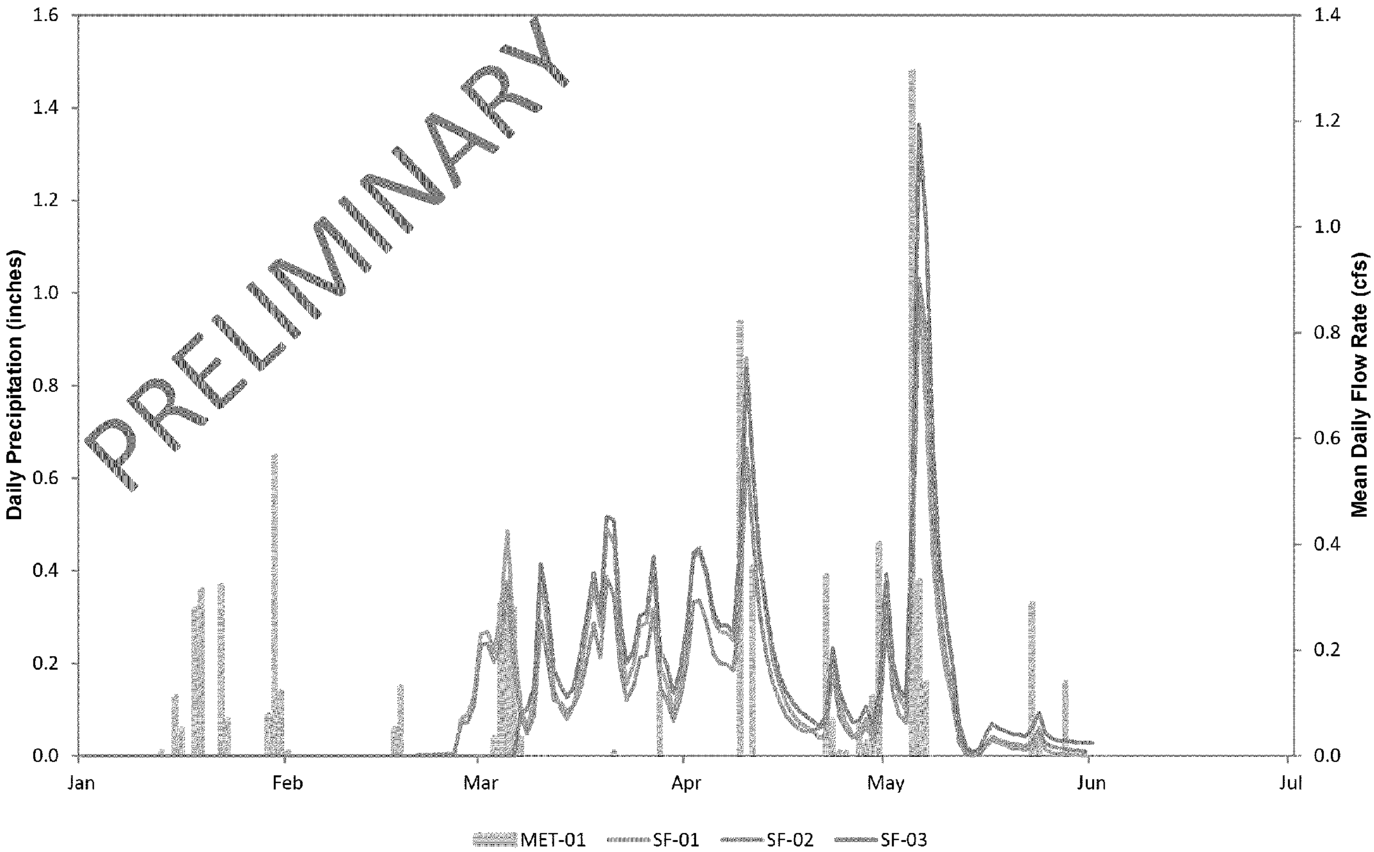
ED_001709_00000302-00042

GRAPH 4-3
2015 PRECIPITATION AND FLOW RATES
Leviathan Mine Site
Alpine County, California



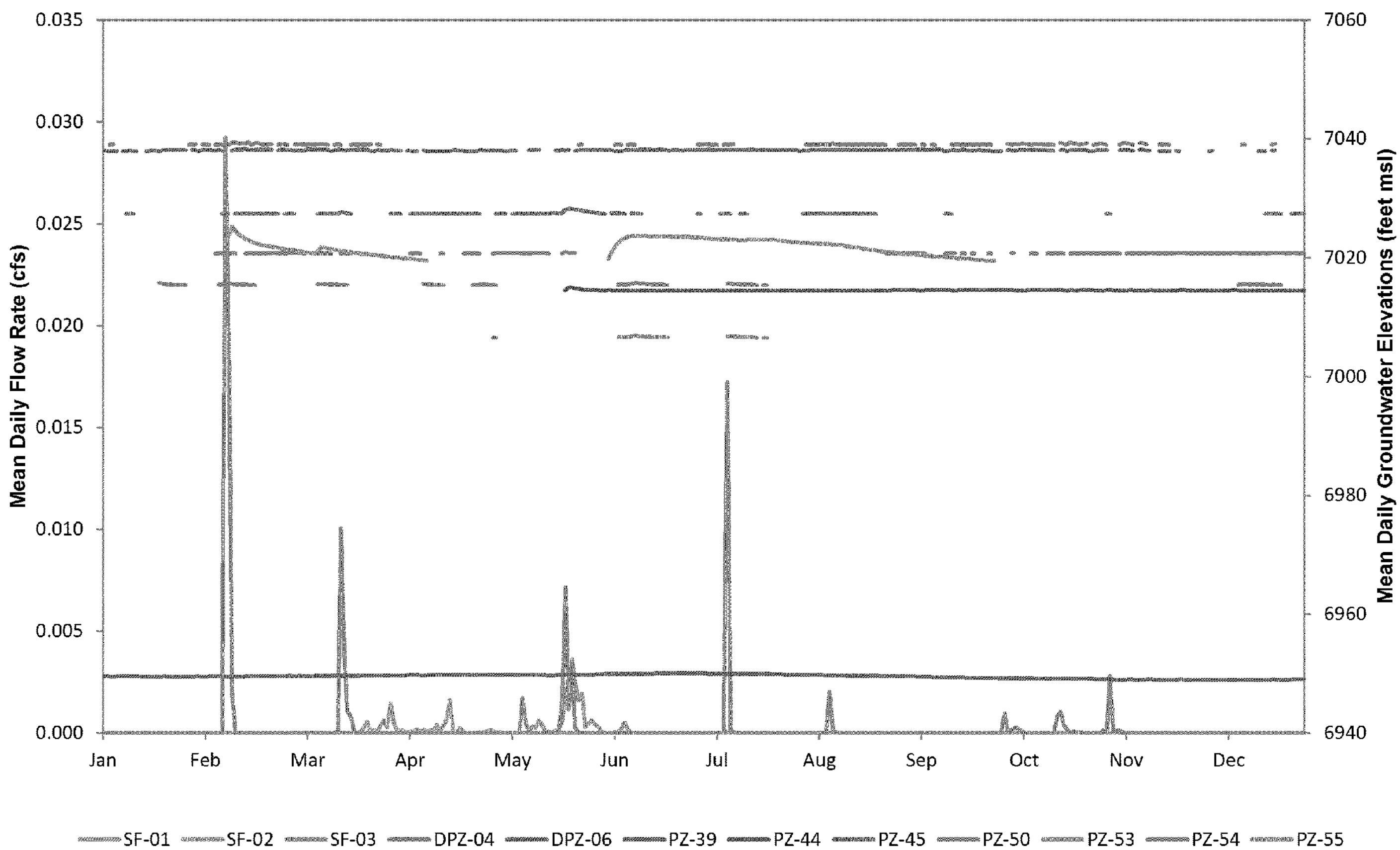
ED_001709_00000302-00043

GRAPH 4-4
2016 PRECIPITATION AND FLOW RATES
Leviathan Mine Site
Alpine County, California

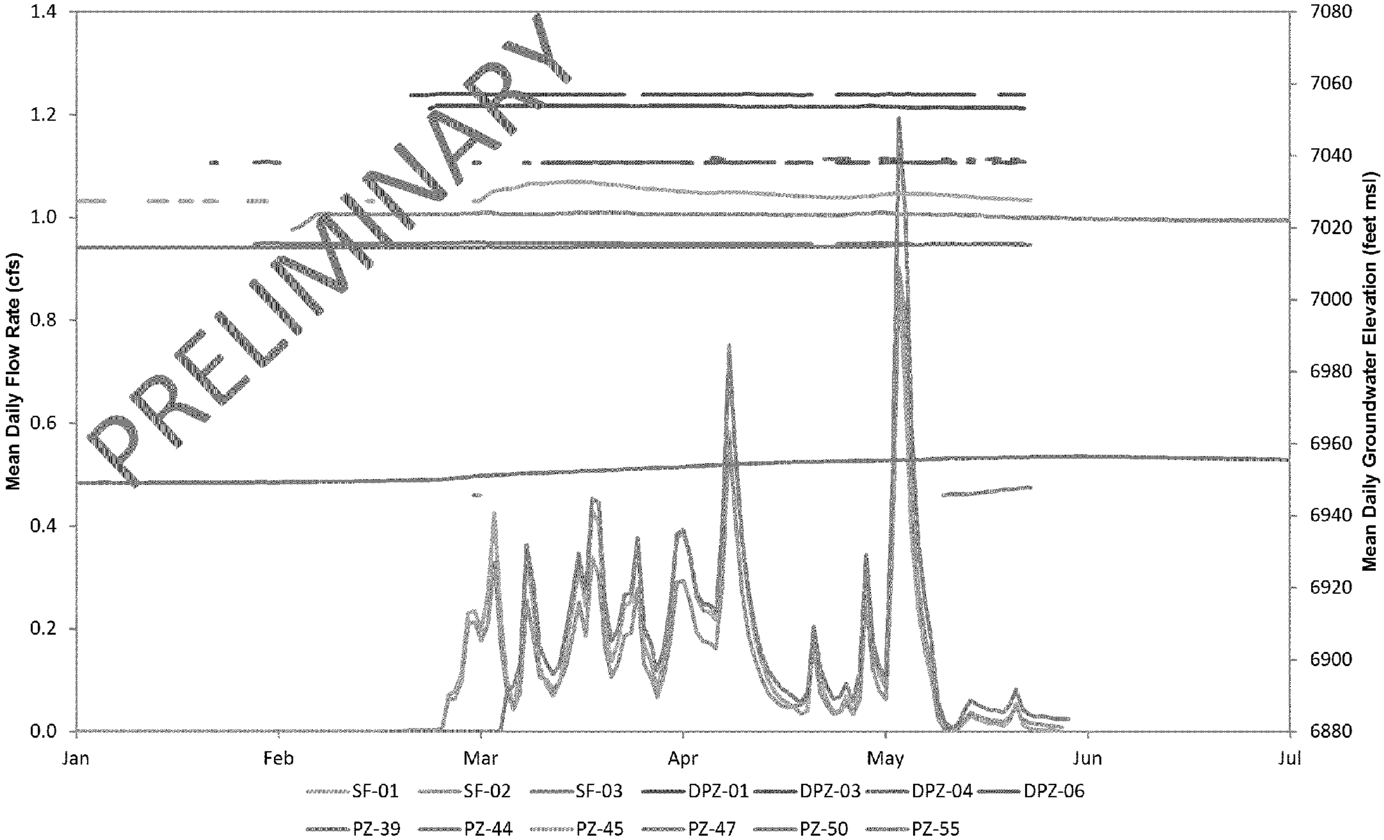


ED_001709_00000302-00044

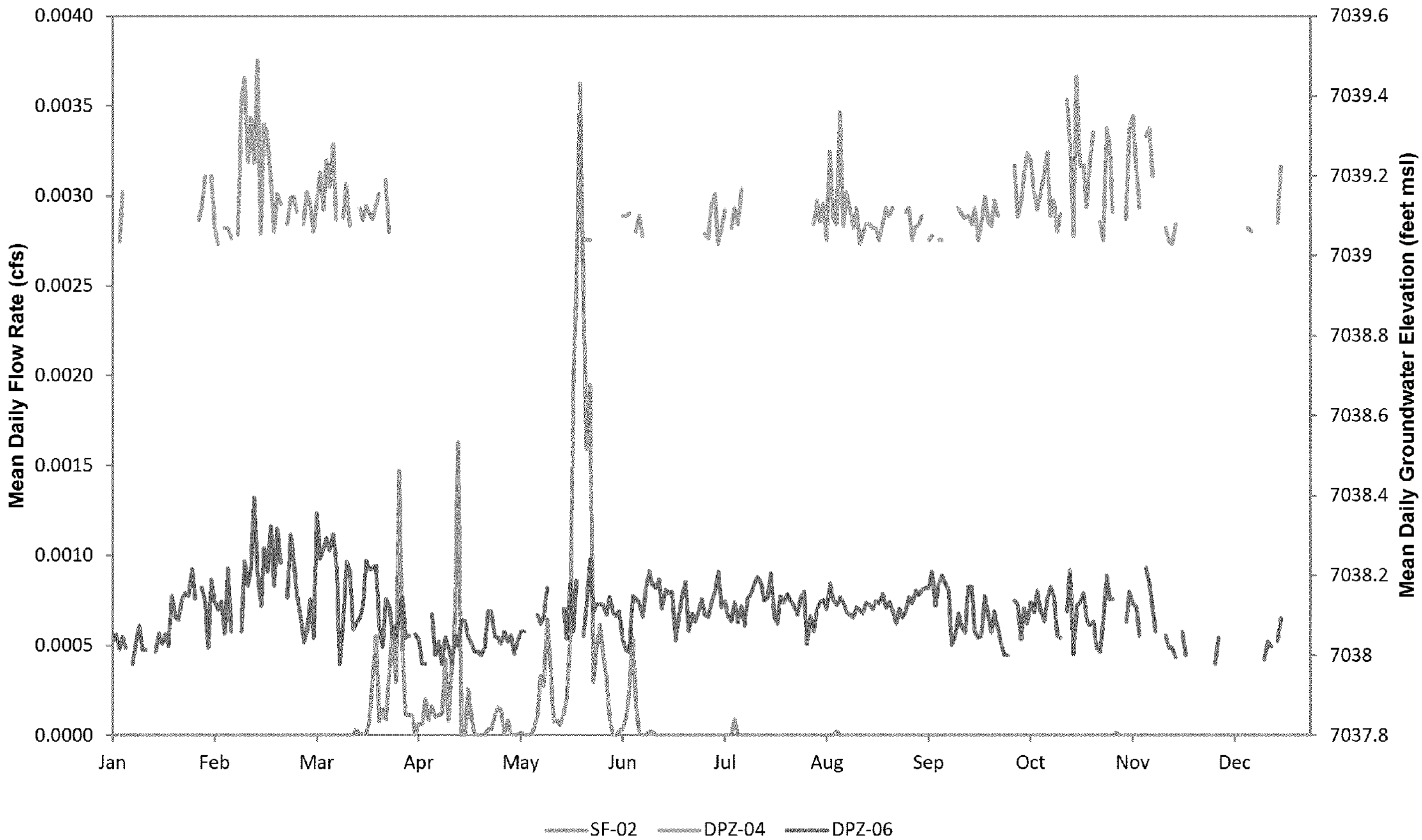
GRAPH 4-5
2015 GROUNDWATER ELEVATIONS AND FLOW RATES (ALL)
Leviathan Mine Site
Alpine County, California



GRAPH 4-6
2016 GROUNDWATER ELEVATIONS AND FLOW RATES (ALL)
Leviathan Mine Site
Alpine County, California

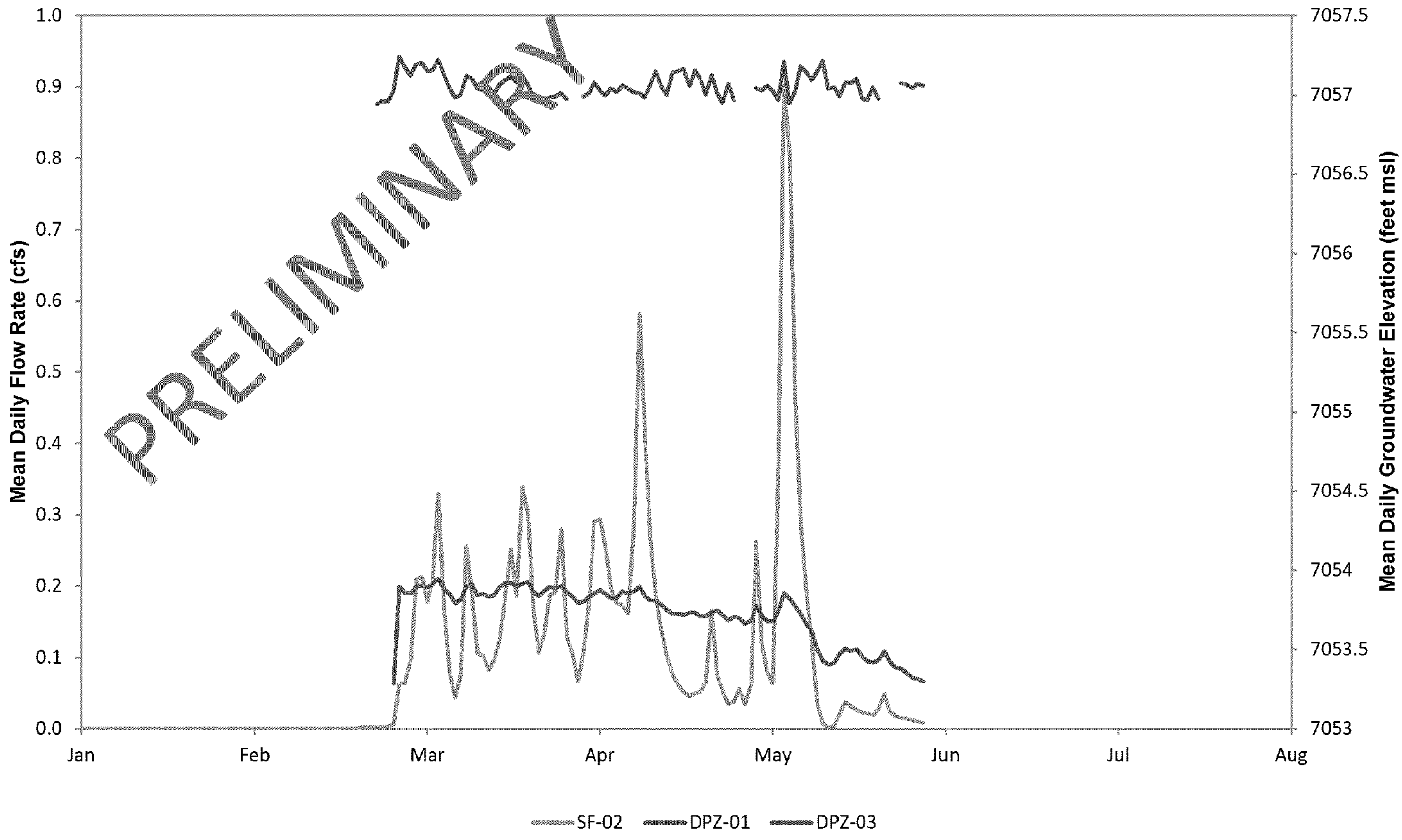


GRAPH 4-7
2015 GROUNDWATER ELEVATIONS (DPZ-04 AND DPZ-06) AND FLOW RATES
Leviathan Mine Site
Alpine County, California



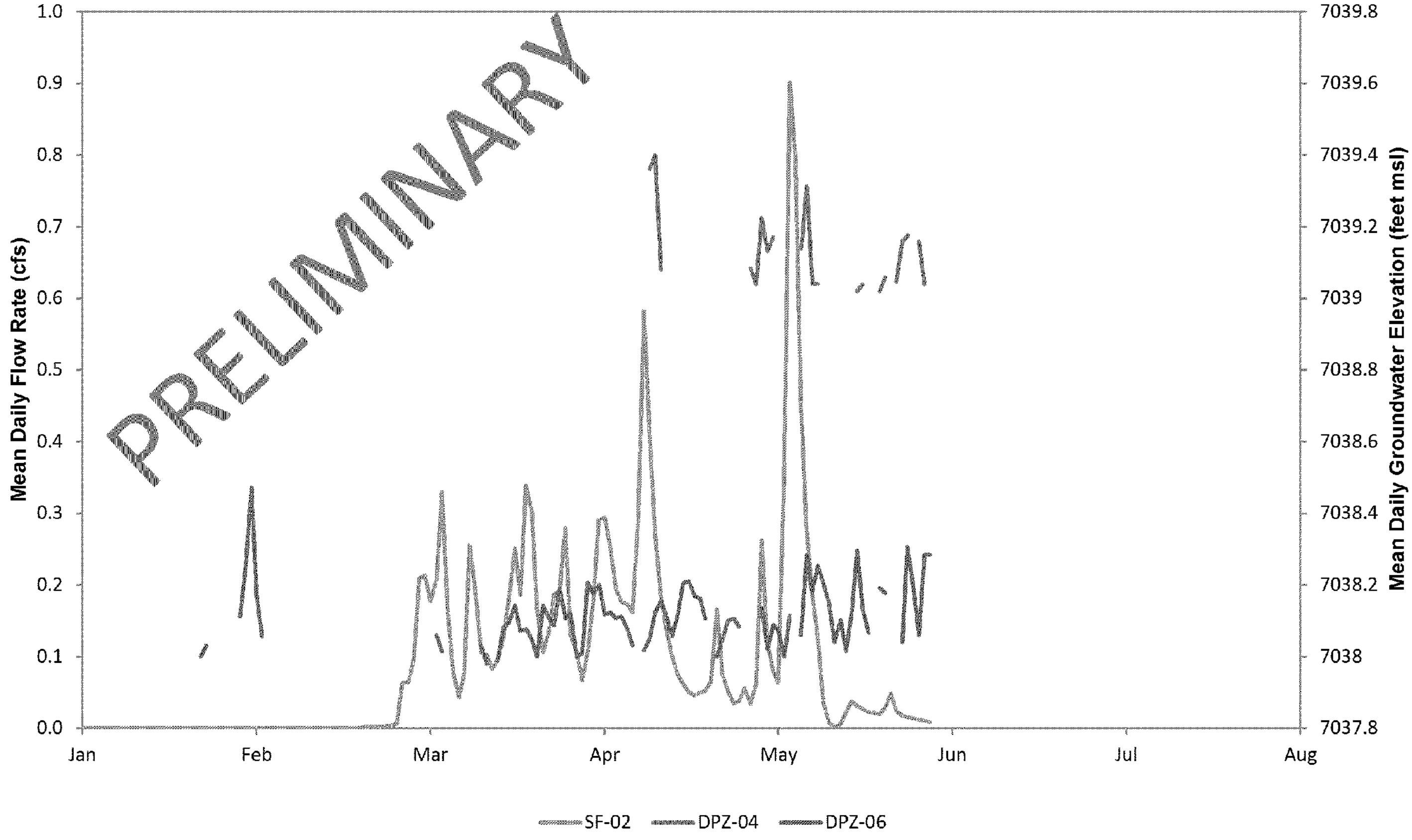
ED_001709_00000302-00047

GRAPH 4-8
2016 GROUNDWATER ELEVATIONS (DPZ-01, DPZ-02, AND DPZ-03) AND FLOW RATES
Leviathan Mine Site
Alpine County, California

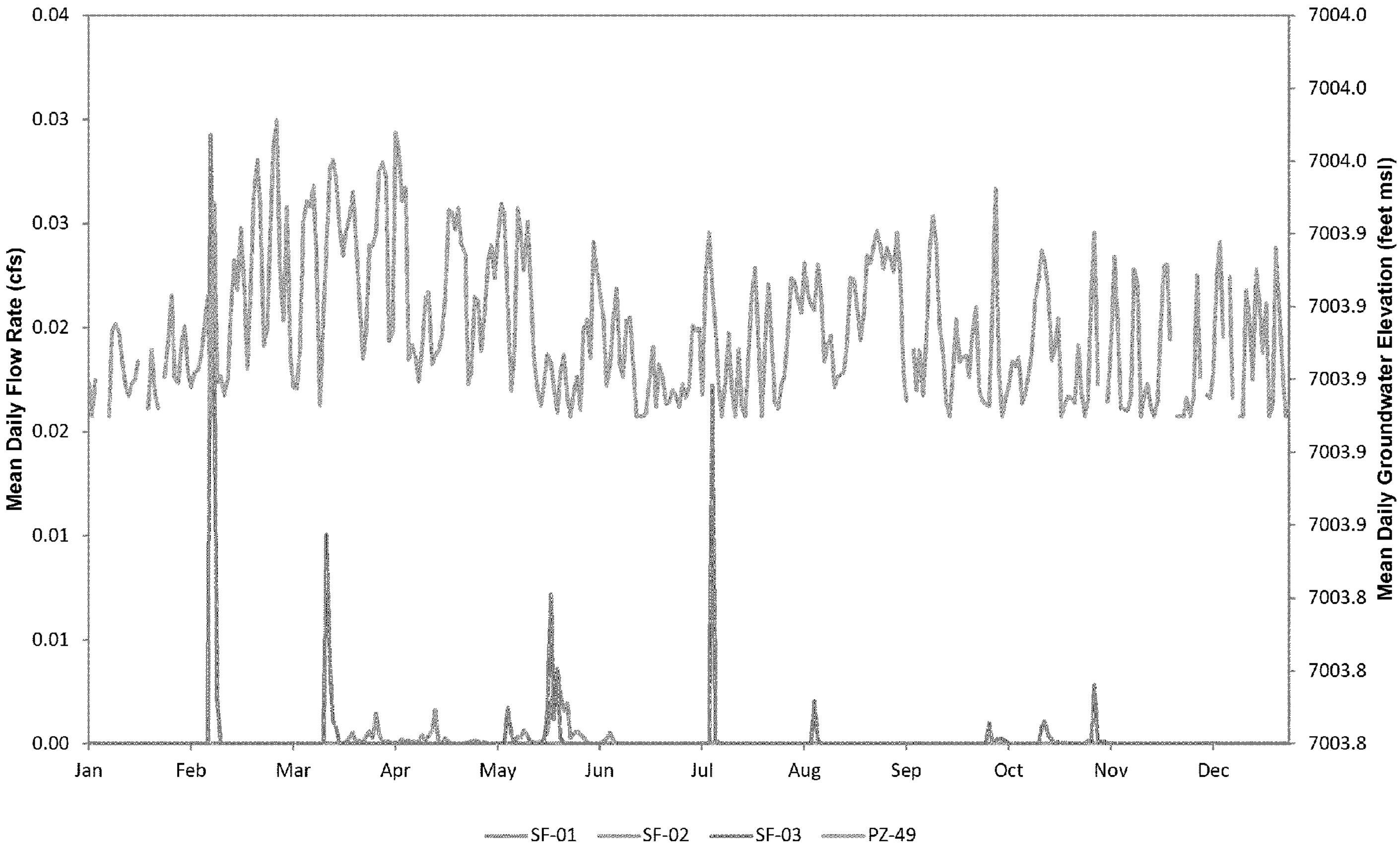


amec foster wheeler

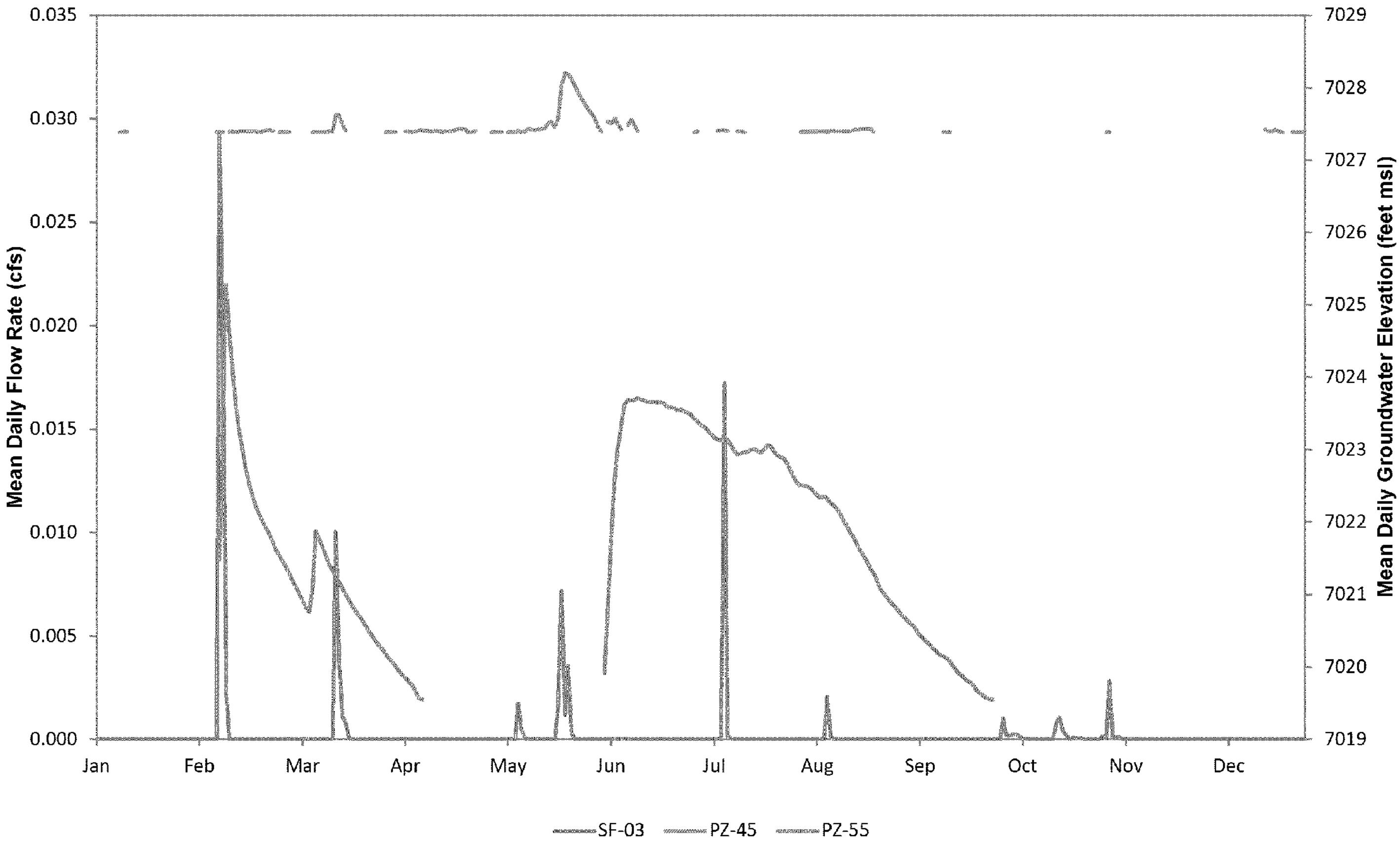
GRAPH 4-9
2016 GROUNDWATER ELEVATIONS (DPZ-04 AND DPZ-06) AND FLOW RATES
Leviathan Mine Site
Alpine County, California



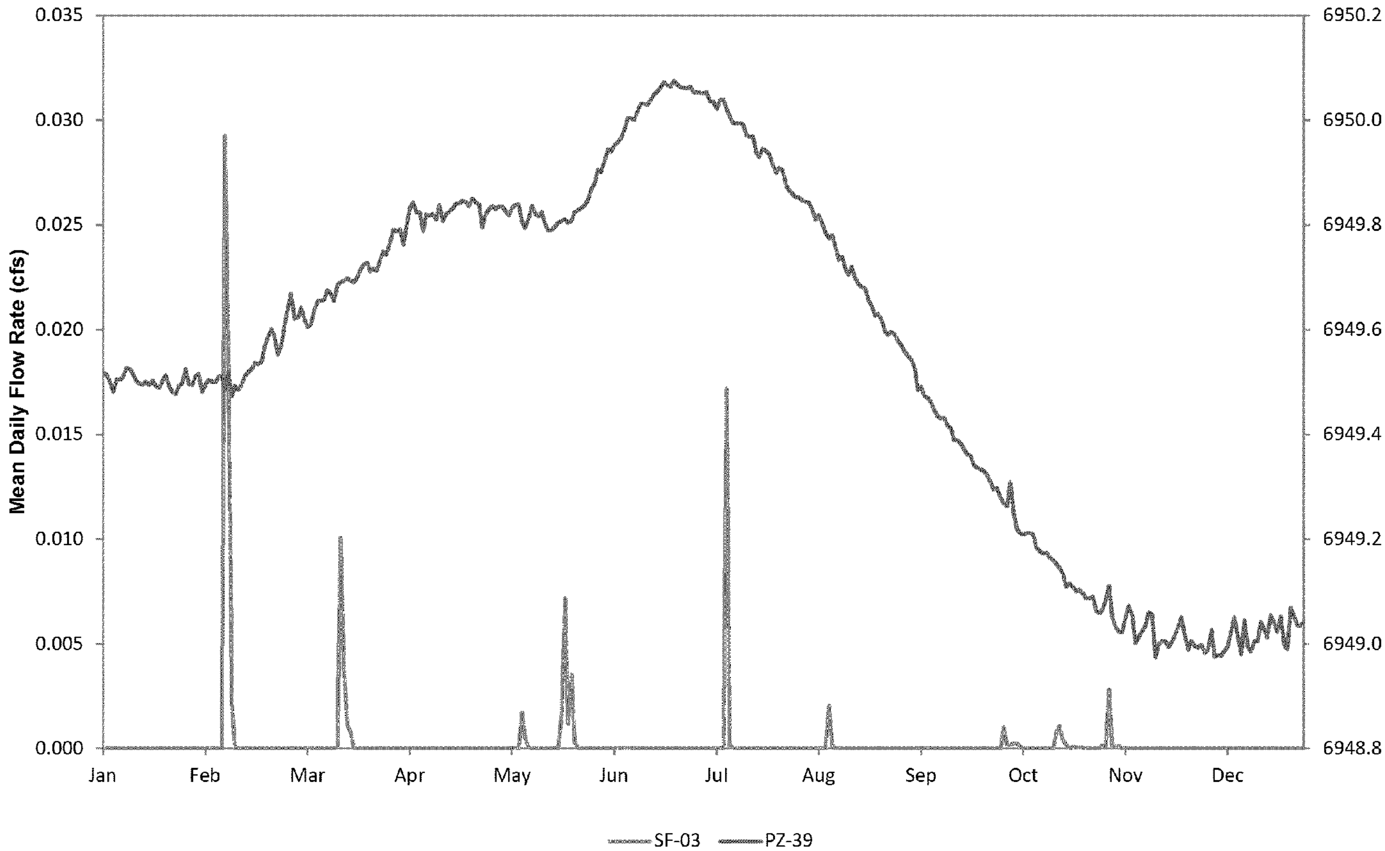
GRAPH 4-10
2015 GROUNDWATER ELEVATIONS (PZ-49) AND FLOW RATES
Leviathan Mine Site
Alpine County, California



GRAPH 4-11
2015 GROUNDWATER ELEVATIONS (PZ-45 AND PZ-55) AND FLOW RATES
Leviathan Mine Site
Alpine County, California

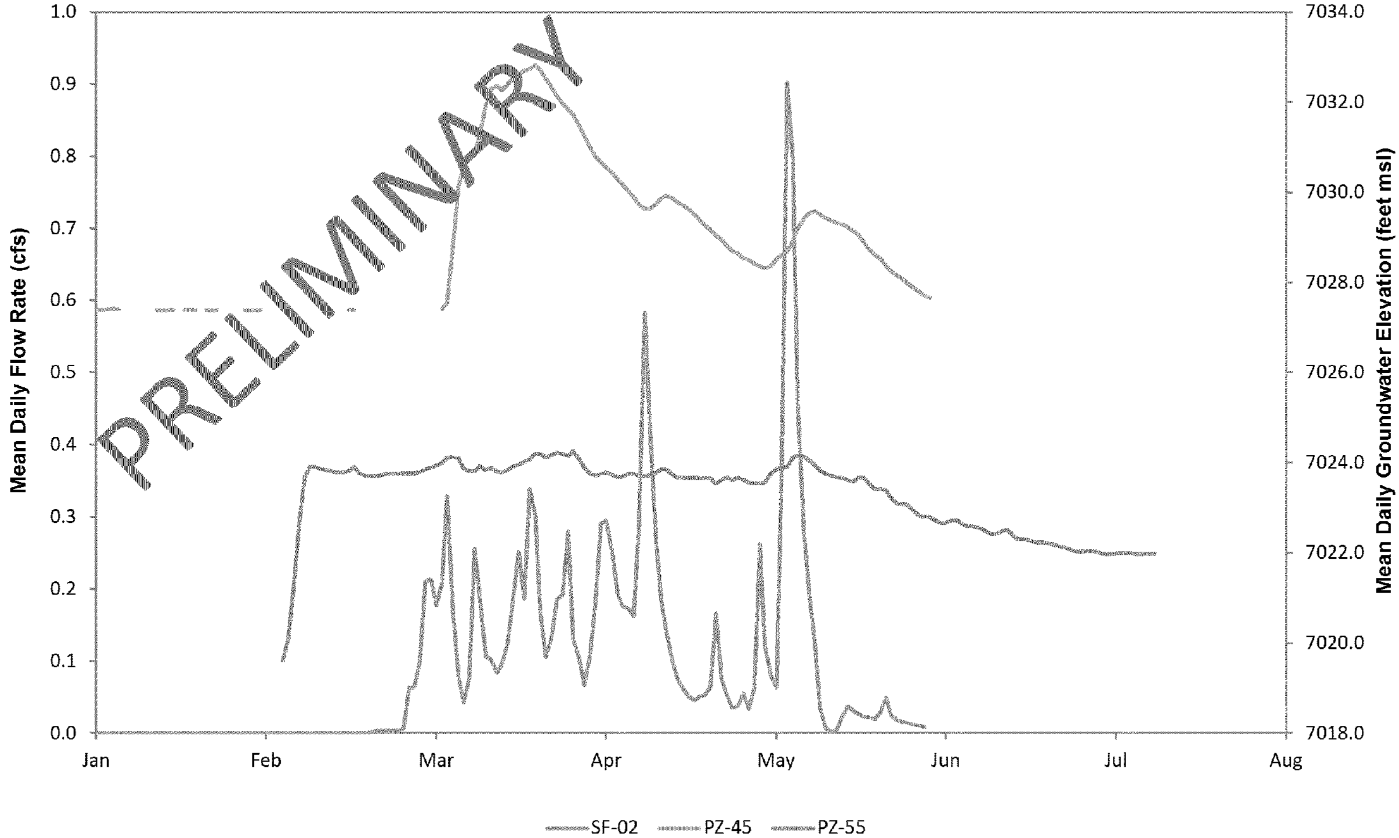


GRAPH 4-12
2015 GROUNDWATER ELEVATIONS (PZ-39) AND FLOW RATES
Leviathan Mine Site
Alpine County, California



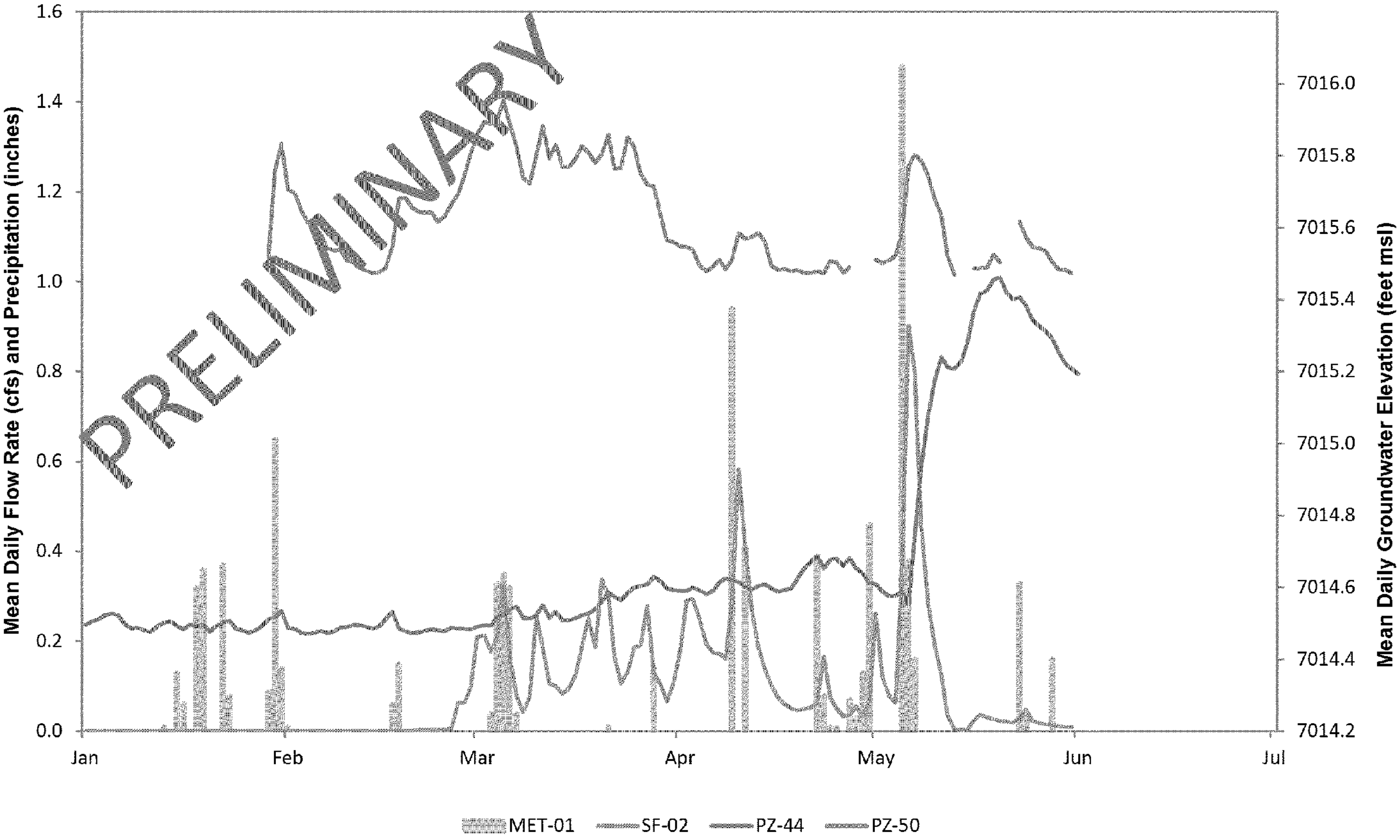
ED_001709_00000302-00052

GRAPH 4-13
2016 GROUNDWATER ELEVATIONS (PZ-45 AND PZ-55) AND FLOW RATES
Leviathan Mine Site
Alpine County, California



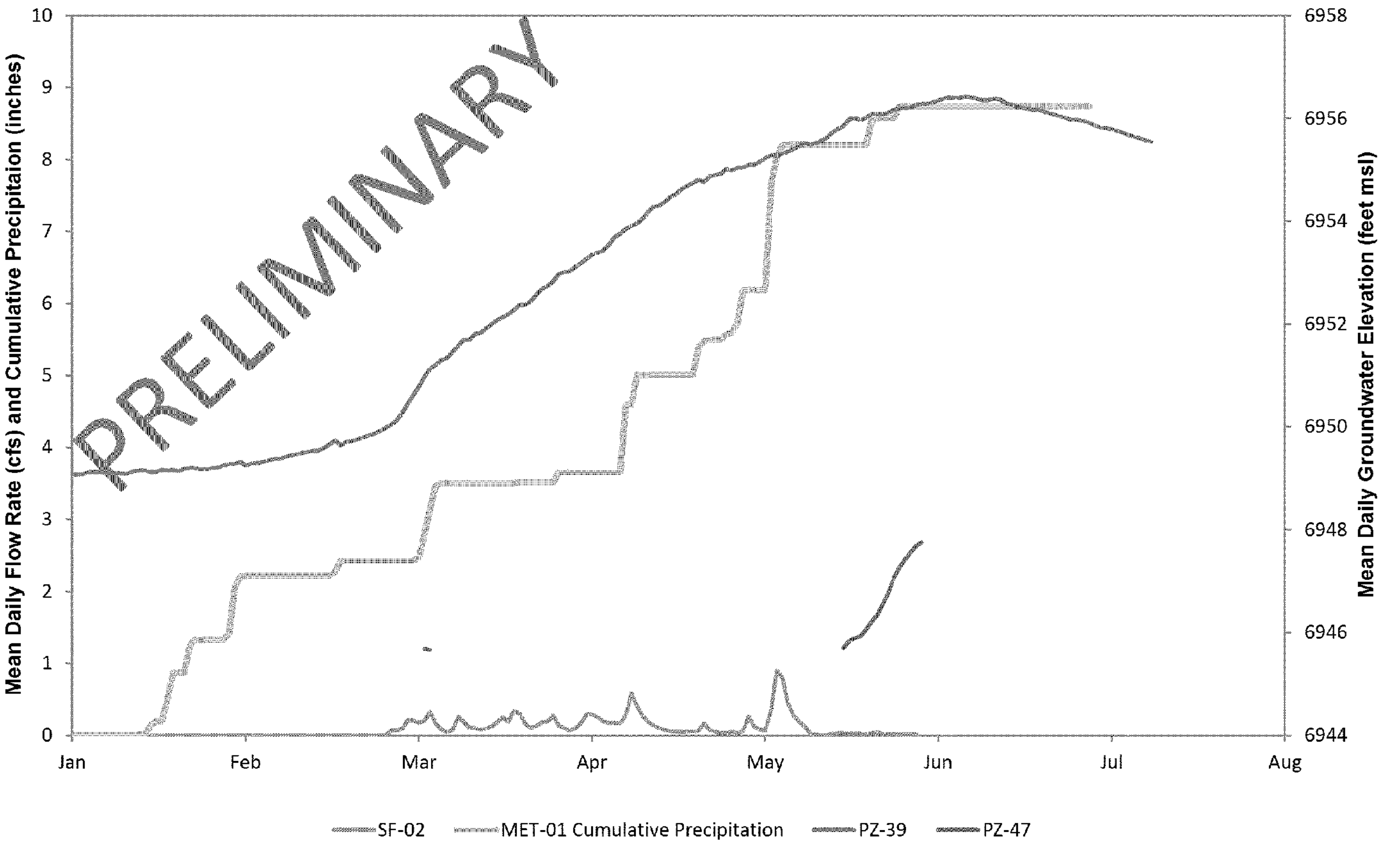
ED_001709_00000302-00053

GRAPH 4-14
2016 GROUNDWATER ELEVATIONS (PZ-44 AND PZ-50), FLOW RATES, AND DAILY PRECIPITATION
Leviathan Mine Site
Alpine County, California

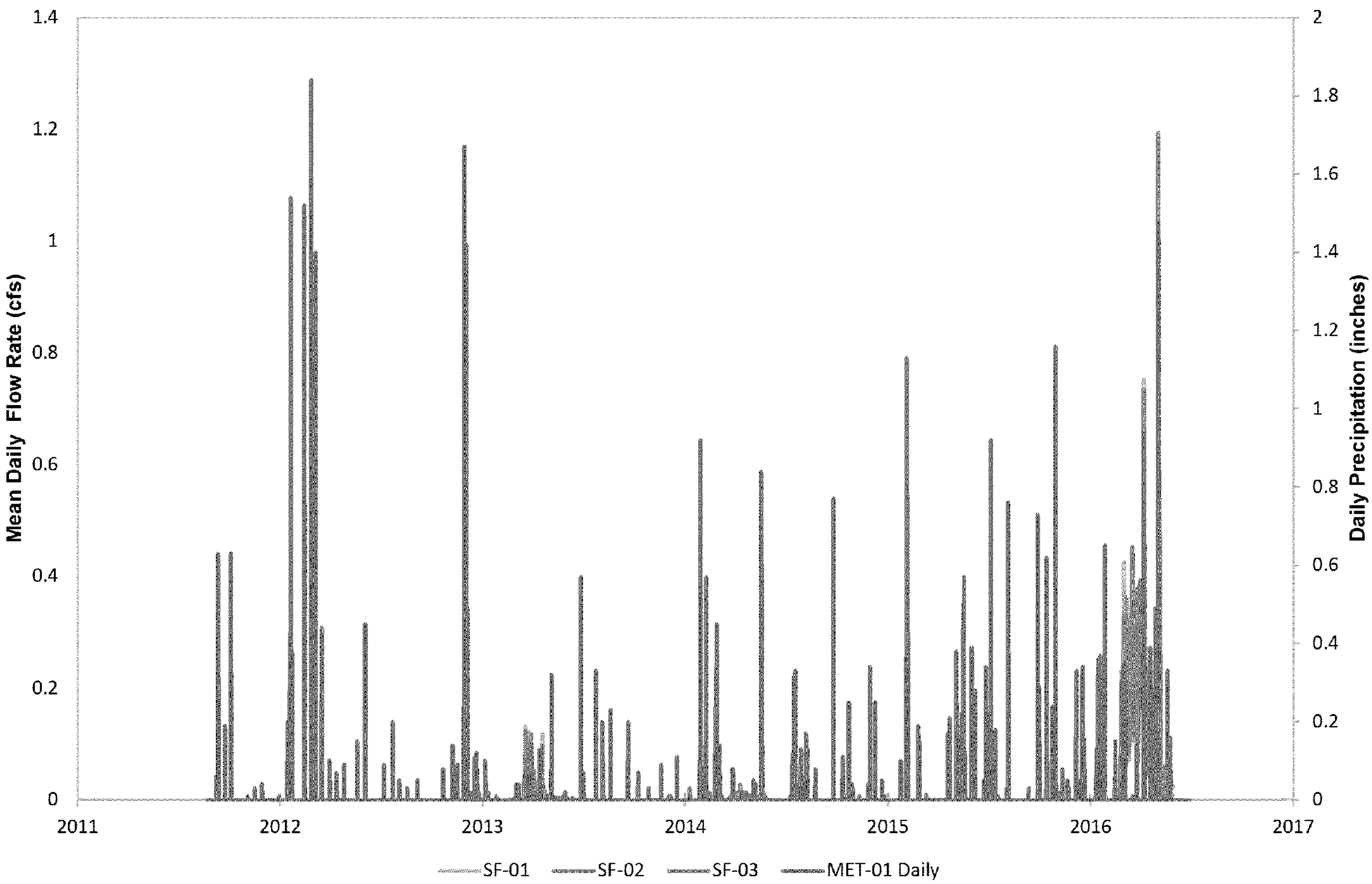


ED_001709_00000302-00054

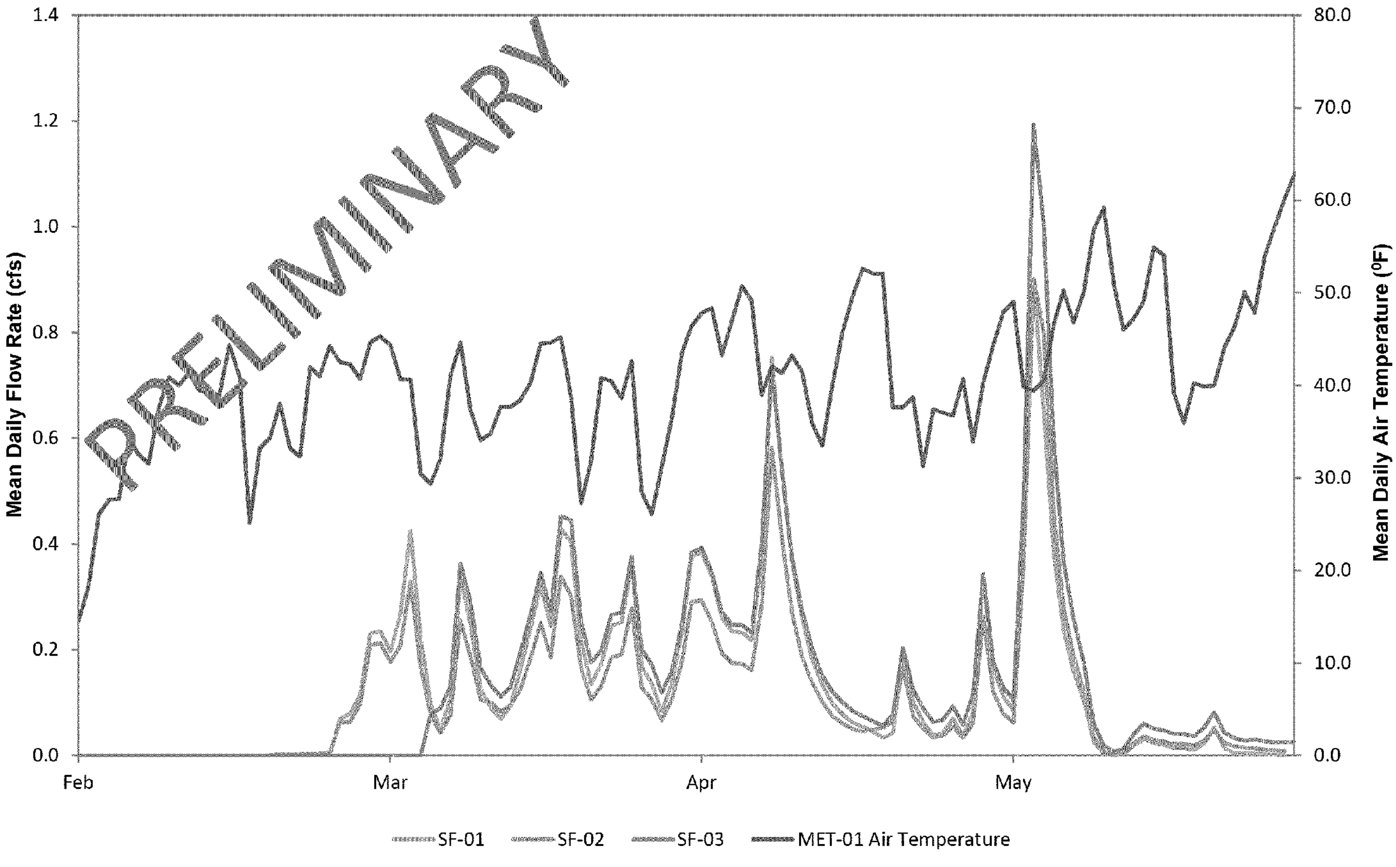
GRAPH 4-15
2016 GROUNDWATER ELEVATIONS (PZ-39 AND PZ-47), FLOW RATES, AND PRECIPITATION
Leviathan Mine Site
Alpine County, California



GRAPH 5-1
UPPER TRIBUTARY FLOW RATES AND PRECIPITATION
Leviathan Mine Site
Alpine County, California

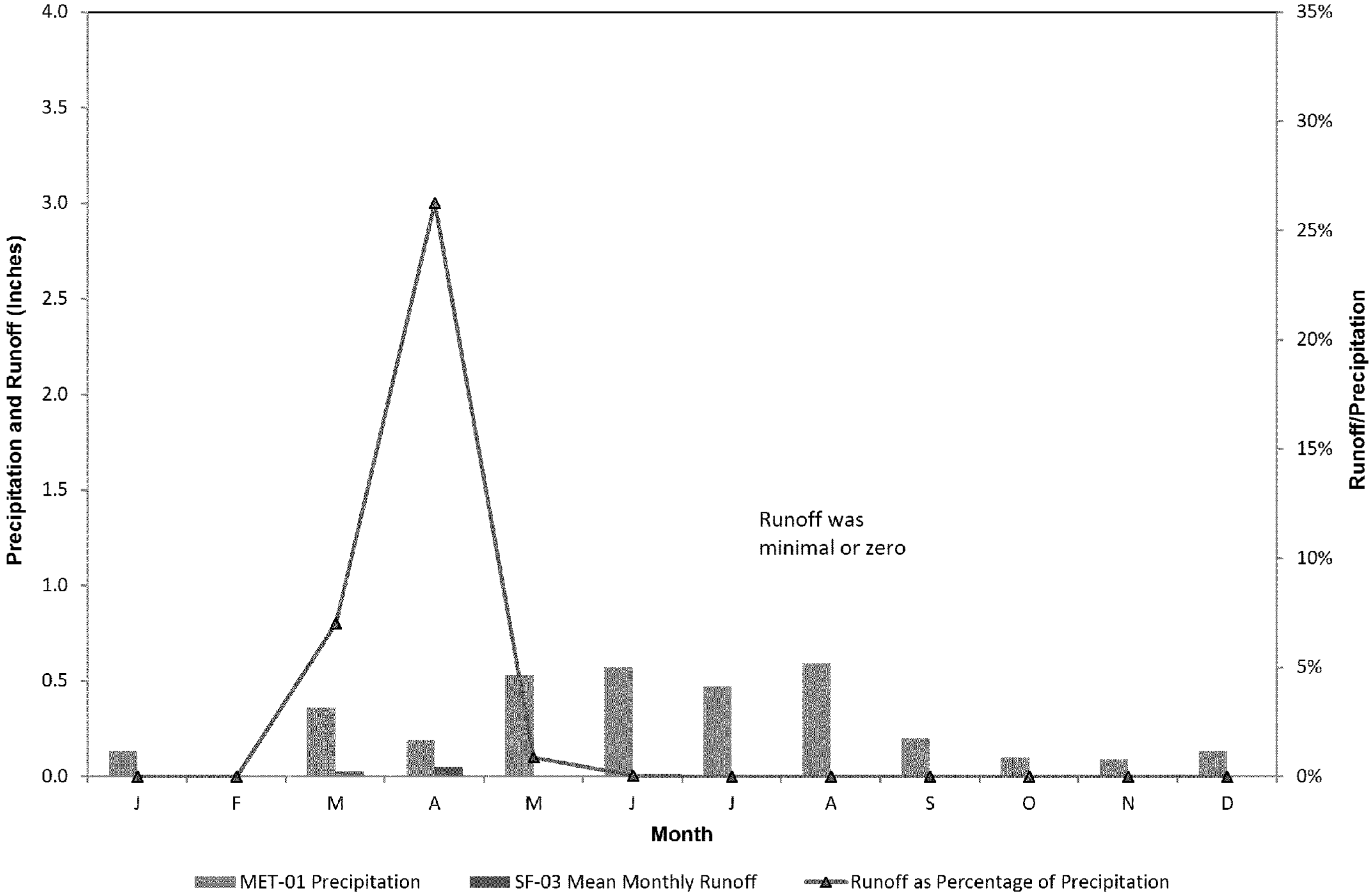


GRAPH 5-2
2016 AIR TEMPERATURES AND FLOW RATES
Leviathan Mine Site
Alpine County, California

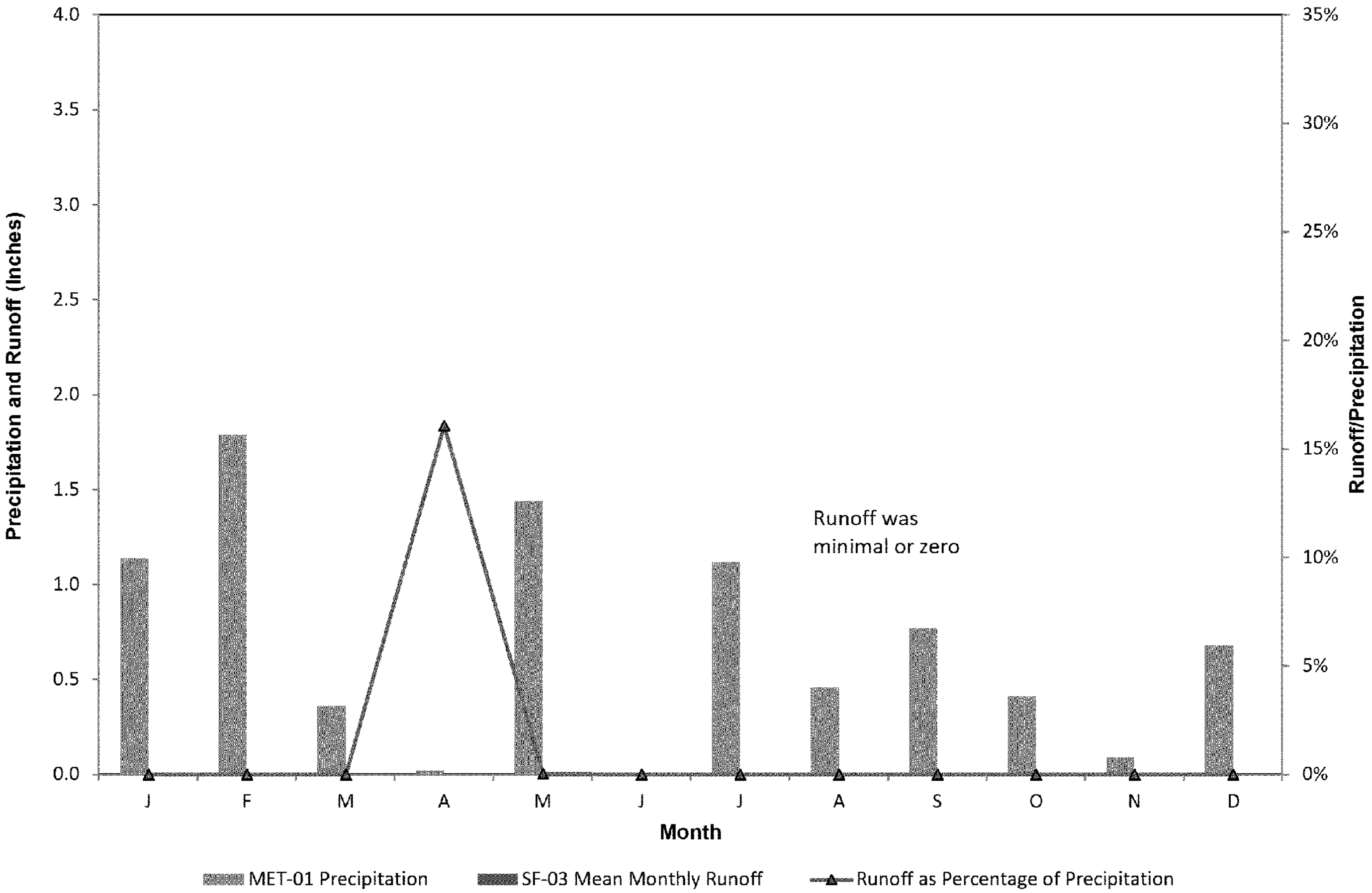


P:\Project\13000s\13091 Leviathan\12000 Calcs_Eval_ Analysis\12070 RIFS\Upper Tributary\2016 UT TDSR\Figures\161031_Graphs 161027 2016 plots_AB161031_Graphs 161027 2016 plots_AB

GRAPH 5-3
2013 UPPER TRIBUTARY MONTHLY RUNOFF
Leviathan Mine Site
Alpine County, California

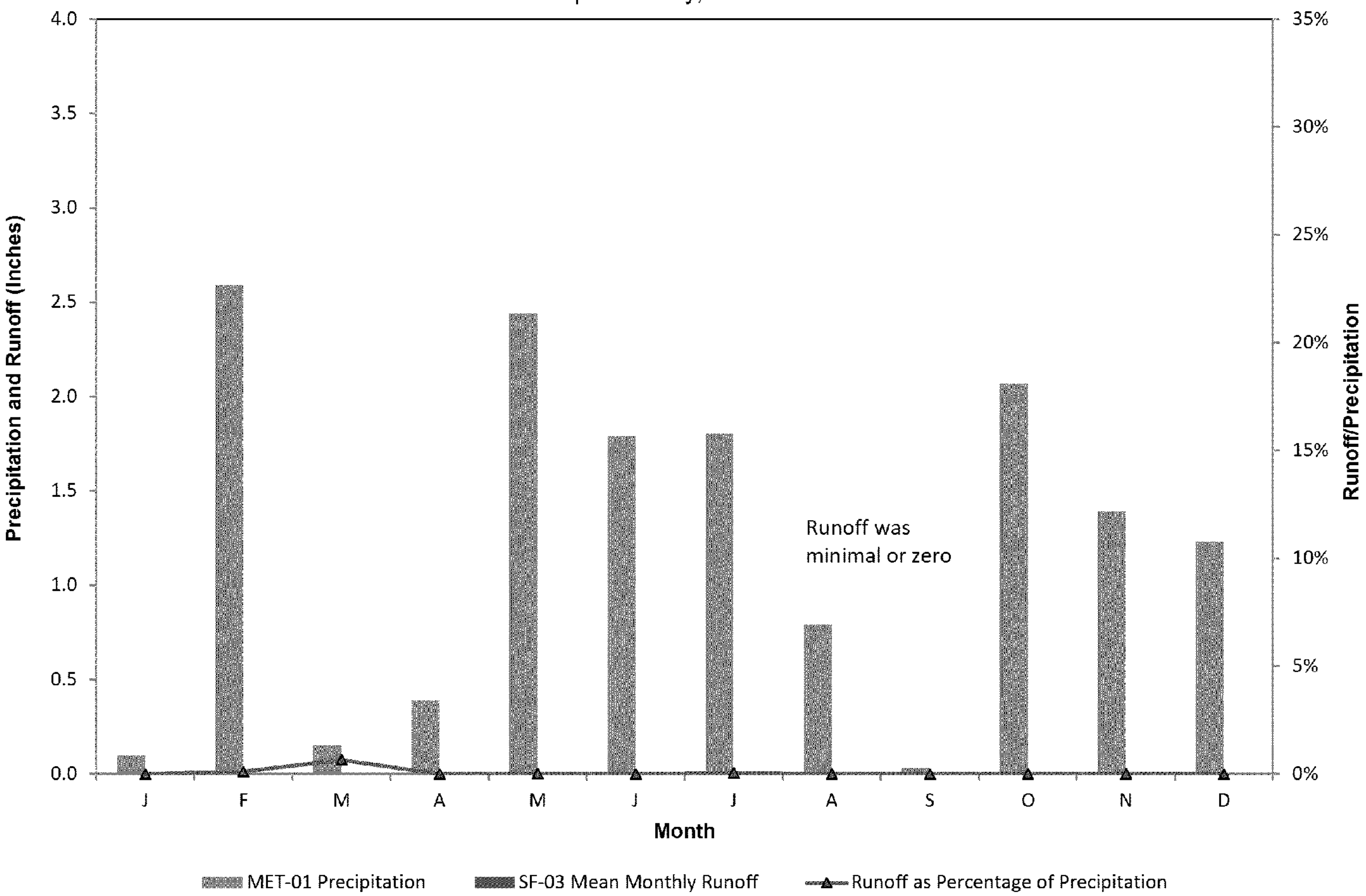


GRAPH 5-4
2014 UPPER TRIBUTARY MONTHLY RUNOFF
Leviathan Mine Site
Alpine County, California



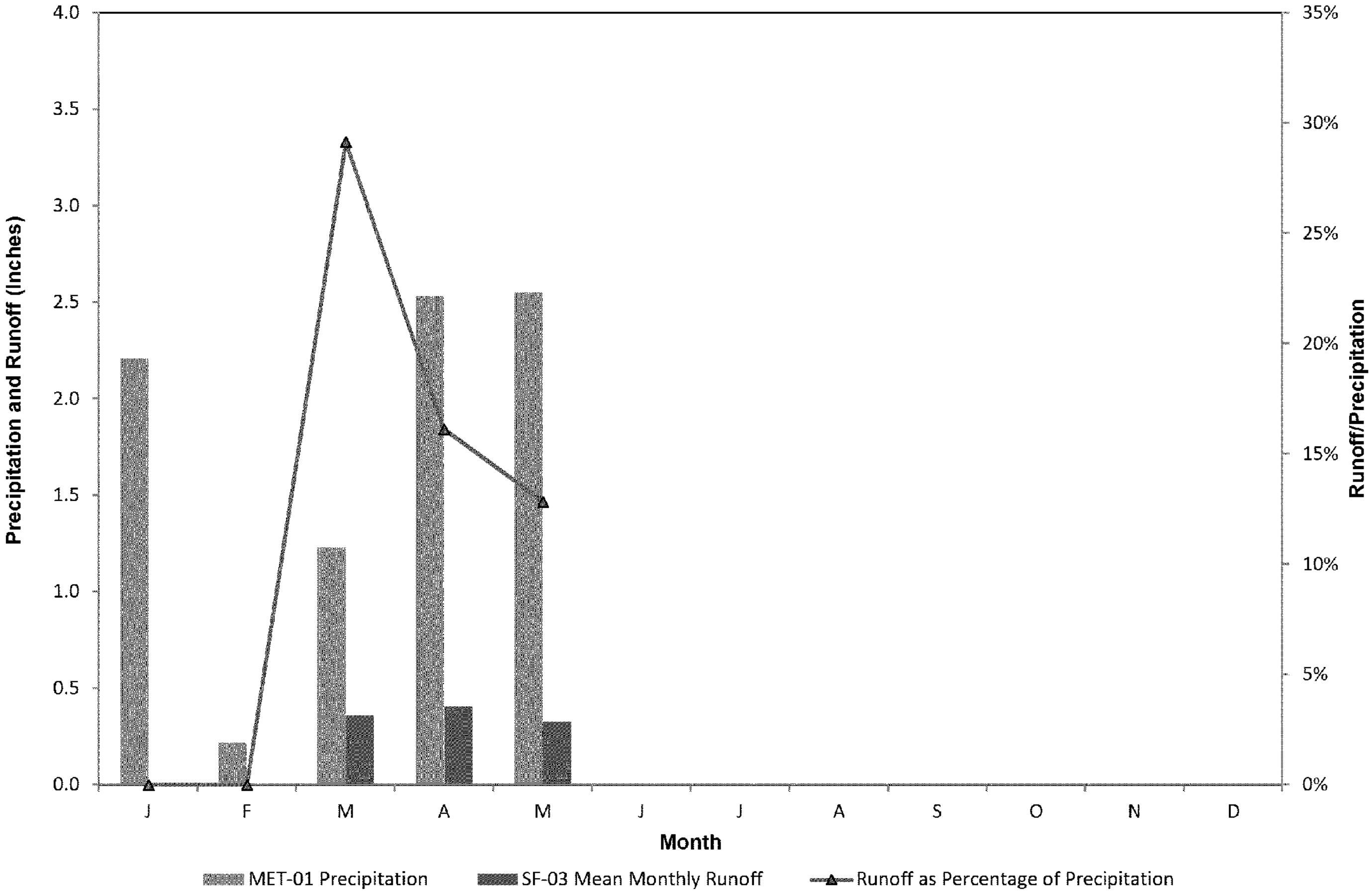
ED_001709_00000302-00059

GRAPH 5-5
2015 UPPER TRIBUTARY MONTHLY RUNOFF
Leviathan Mine Site
Alpine County, California

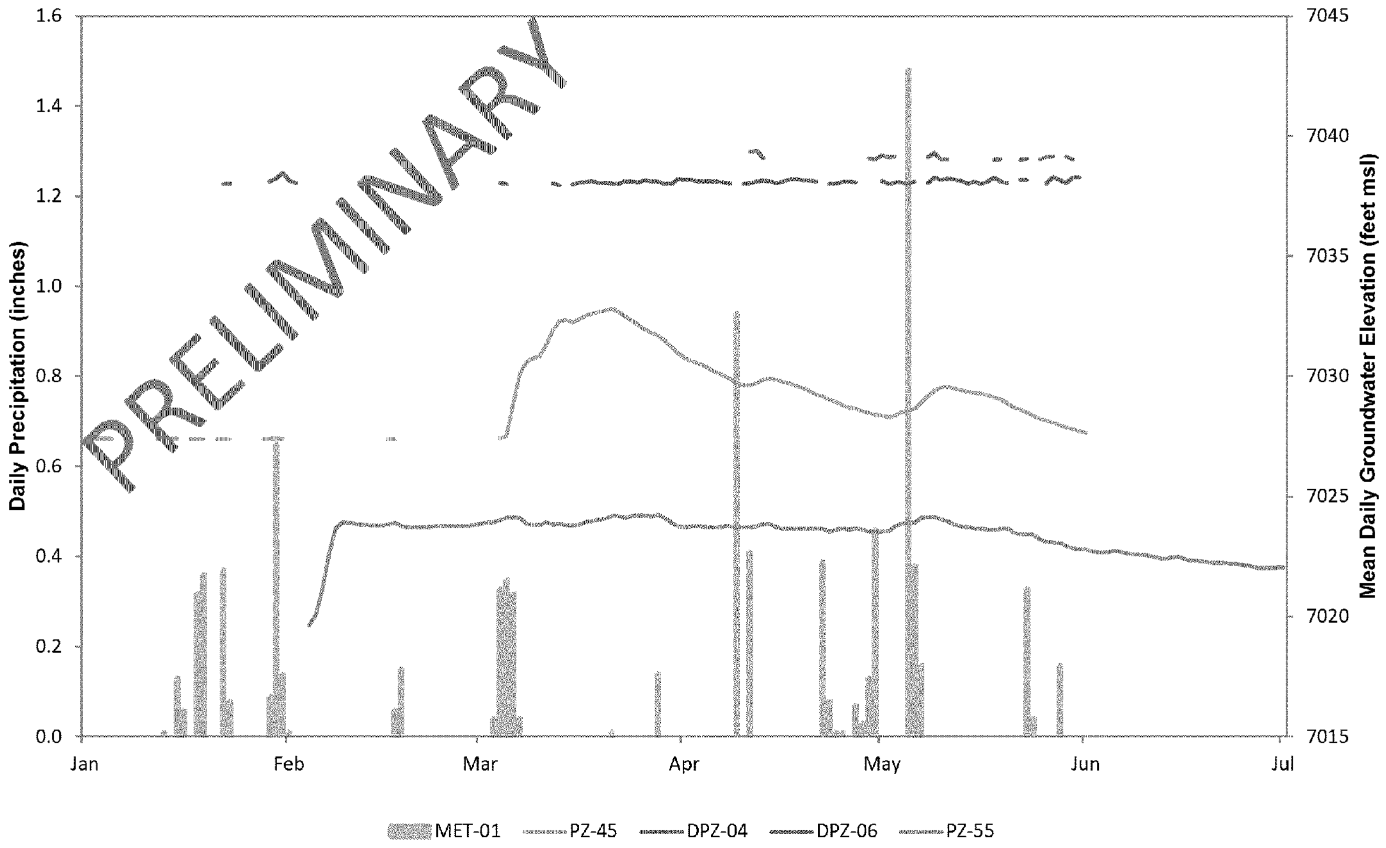


ED_001709_00000302-00060

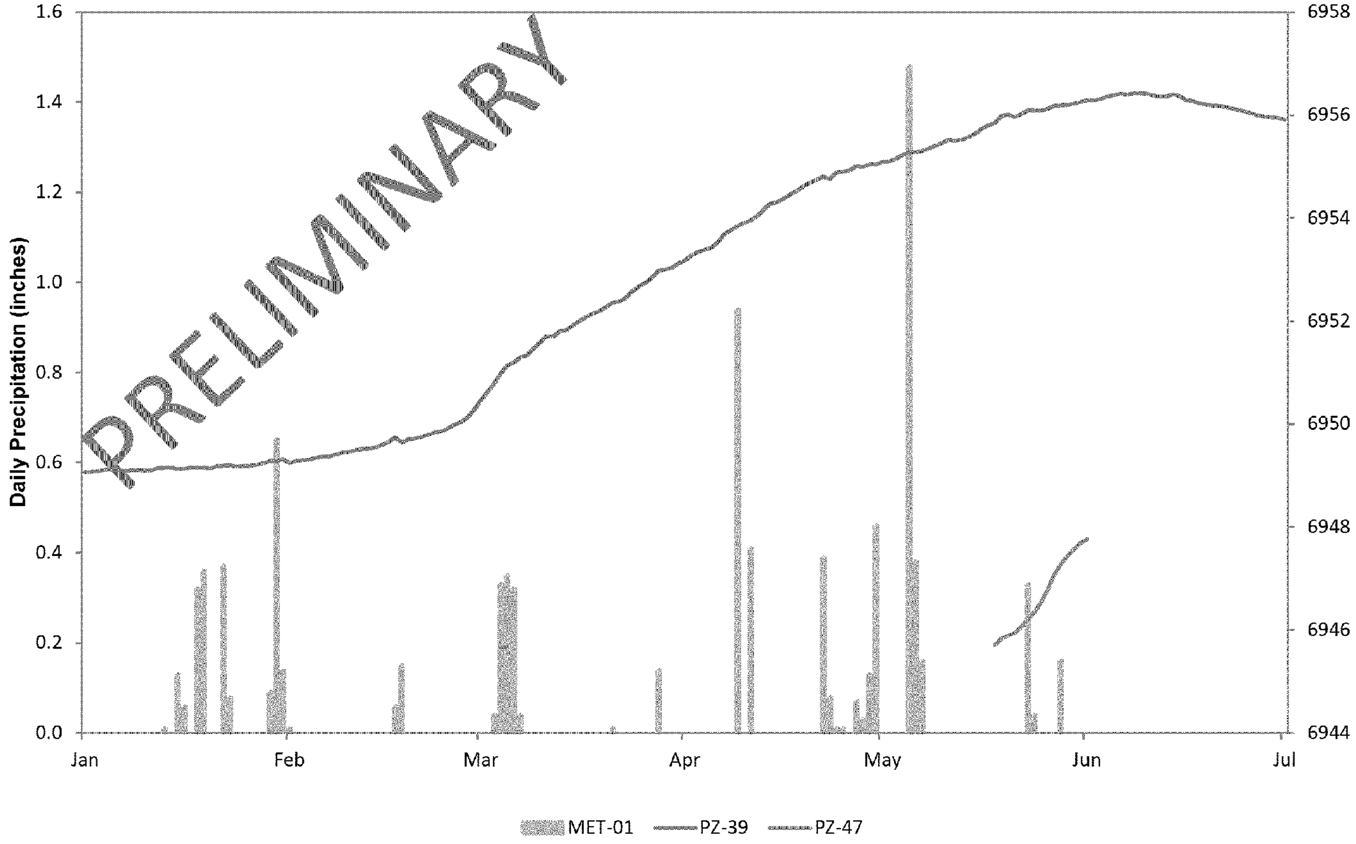
GRAPH 5-6
2016 UPPER TRIBUTARY MONTHLY RUNOFF
Leviathan Mine Site
Alpine County, California



GRAPH 5-7
2016 GROUNDWATER ELEVATIONS (DRIVE POINTS AND SHALLOW PIEZOMETERS) AND PRECIPITATION
Leviathan Mine Site
Alpine County, California

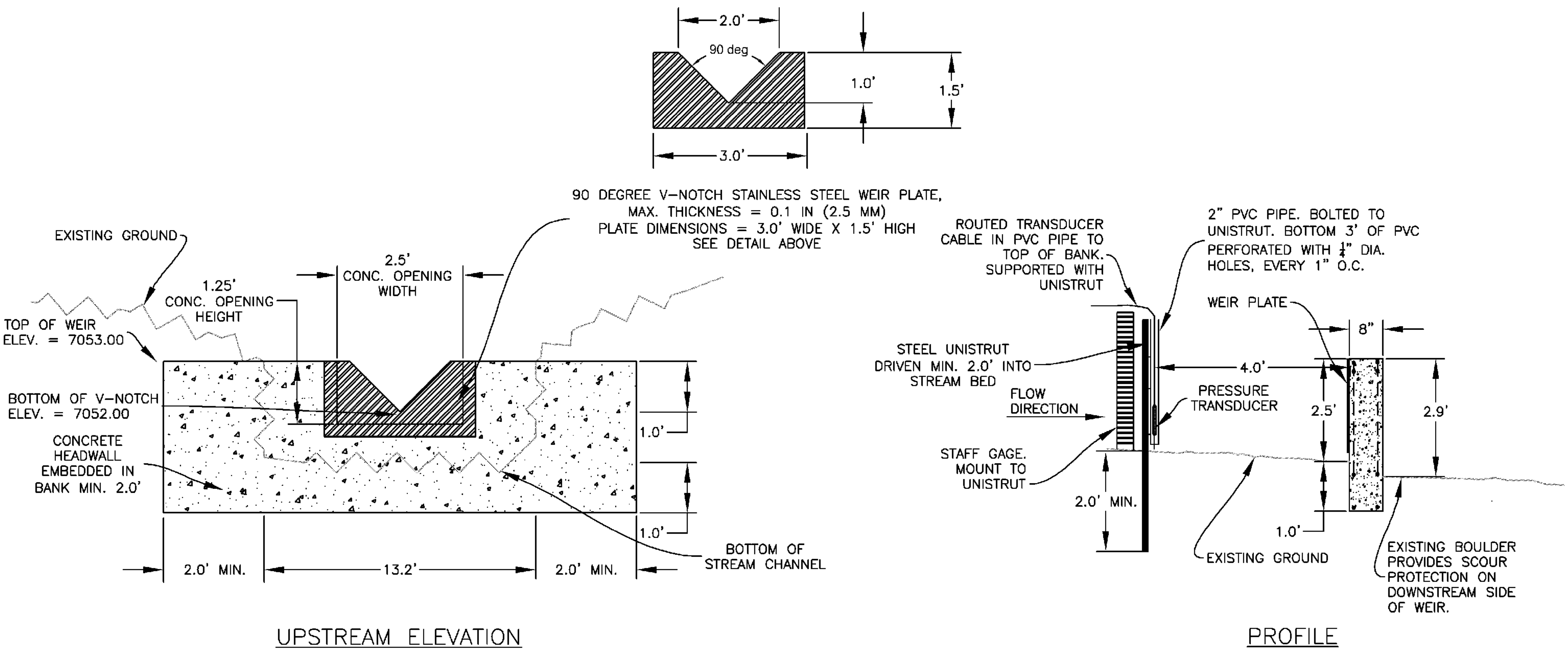


GRAPH 5-8
2016 GROUNDWATER ELEVATIONS (DEEP PIEZOMETERS) AND PRECIPITATION
Leviathan Mine Site
Alpine County, California



APPENDIX A

Flow Measurement Stations – Design Drawings and Photographs



LOCATION OF WEIR

NORTHING: 2025907.199
EASTING: 7228716.314
COORDINATE SYSTEM: NAD83, CALIFORNIA STATE PLANE ZONE 2, FT

NOT TO SCALE

NOTE:
1. CONC. = CONCRETE

REFERENCES:	NO.	REVISION	DATE	APRVD
PLANS	1	AS-BUILT	5/6/13	AGM
DATUM				

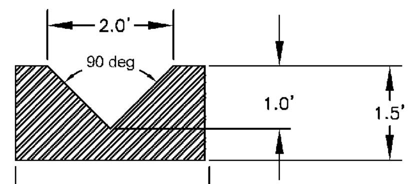
DRAWN
DESIGNED JRH
CHECKED AGM
REVIEWED

AMEC Geomatrix Inc.
10670 White Rock Road, Suite 100
Rancho Cordova, CA 95670
(916) 636-3200

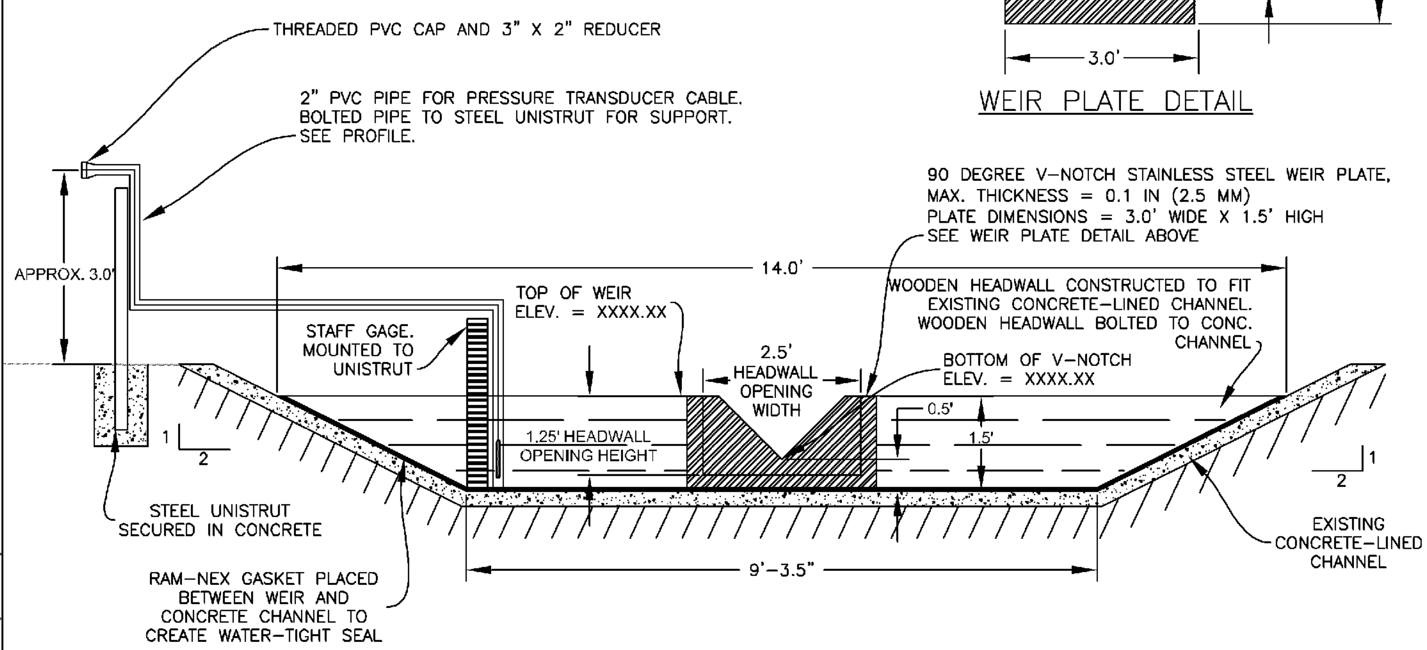
LEVIATHAN MINE SITE
ALPINE COUNTY, CALIFORNIA

FLOW MEASUREMENT STATION INSTALLATION LOCATION SF-01

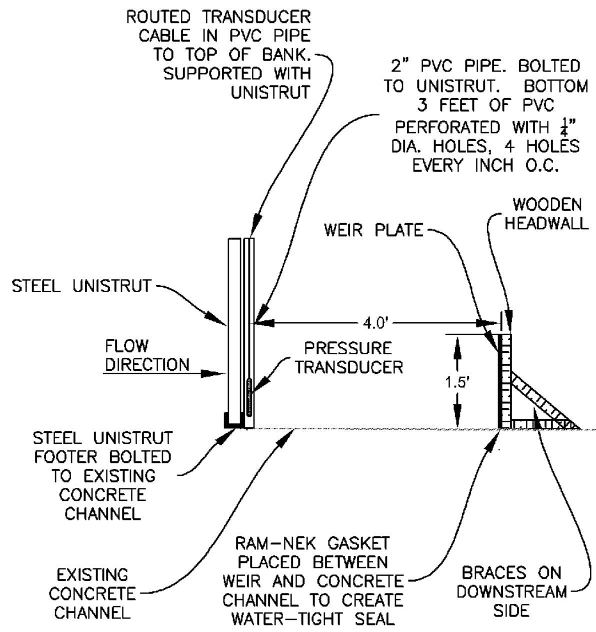
DATE: 7/18/2013
SCALE: As Noted
SHEET 1 OF 2 SHEETS
PROJ. NO: 0013091 | 1



WEIR PLATE DETAIL



UPSTREAM ELEVATION



PROFILE

LOCATION OF WEIR

NORTHING: 2025979.860
EASTING: 7228756.504
COORDINATE SYSTEM: NAD83, CALIFORNIA STATE PLANE ZONE 2, FT

NOTE:
1. XXXX.XX. LOCATION TO BE SURVEYED IN 2013.

REFERENCES:	NO.	REVISION	DATE	APPVD
PLANS	1	AS-BUILT	5/6/13	AGM
DATUM				

DRAWN
DESIGNED JRH
CHECKED AGM
REVIEWED

amec
AMEC Geomatrix Inc.
10670 White Rock Road, Suite 100
Rancho Cordova, CA 95670
(916) 636-3200

LEVIATHAN MINE SITE
ALPINE COUNTY, CALIFORNIA

FLOW MEASUREMENT STATION INSTALLATION LOCATION SF-02

DATE: 7/18/2013
SCALE: As Noted
SHEET 2 OF 2 SHEETS
PROJ. NO: 0013091
2

ED_001709_00000302-00066

SF-01
Finished weir, staff gage, and transducer conduit
(facing northeast)

SF-02
Finished weir, staff gage, and transducer conduit
(facing southwest)

SF-03
Existing weir with new staff gage, and transducer conduit
(facing southwest)

PHOTOS
Leviathan Mine Site
Alpine County, California

By: dpv	Date: 07/18/2013	Project No. 13091
amec		Attachment A

amec foster wheeler

APPENDIX B

Exploration Borehole Logs

PROJECT: LEVIATHAN MINE SITE, Alpine County, California	Log of Boring No.B-39
CLIENT: Atlantic Richfield Company	Monitoring Well / Piezometer ID:PZ-39

BORING LOCATION: LCSA	ELEVATION (feet) 7041.02	NORTHING/EASTING 2026449.74 N / 7228803.51 E	
DRILLING CONTRACTOR: Boart Longyear	DATE STARTED: 10/11/2011	DATE FINISHED: 10/14/2011	
DRILLING EQUIPMENT: Prosonic 300T	TOTAL DEPTH (feet): 128	MEASURING POINT: Ground surface	
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): 105 feet / 84.54 feet		
SAMPLING METHOD: 4" Sonic core tool	SCREEN INTERVAL (feet): 103.2-107.8	TOC ELEVATION (feet): 7040.79	
BOREHOLE DIAMETER: 6" (0-110') / 4" (110-128')	LOGGED BY: E. Morita	REVIEWED BY: J. Klein, PG 8341	

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
	0	10:54 Run 1								POORLY GRADED SAND with GRAVEL (SP): pinkish gray (5YR 6/2), dry, ~80% medium to coarse sand, ~20% fine angular gravel, loose	MINE WASTE	Traffic Box	Begin drilling at 10:54
7040.0	1												Easy drilling
7039.0	2									SANDY LEAN CLAY with GRAVEL (CL): multicolored brownish yellow (10YR 6/6), gray (7.5YR 5/1), and greenish gray (6/10G), ~65% fines, ~20% fine to coarse angular sand, ~15% fine angular gravel, low plasticity, low density		Cement Bentonite (3-5%) Grout	
7038.0	3												
7037.0	4												
7036.0	5	10:56 / 11:23 Run 2										Casing - Schedule 40 PVC, 2" dia.	
7035.0	6												
7034.0	7												
7033.0	8												
7032.0	9												
7031.0	10	11:26 / 11:40 Run 3								SANDY LEAN CLAY (CL): yellow (10YR 7/6), moist, ~60% fines, ~35% fine to coarse sand, ~5% fine gravel, low plasticity, firm, occasional white tuff gravel-sized angular fragments			
7030.0	11												
7029.0	12												
7028.0	13												
7027.0	14												
7026.0	15	11:43											

See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company	Log of Boring No.B-39 (CONT.) Monitoring Well / Piezometer ID:PZ-39 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		12:15								SANDY LEAN CLAY (CL): continued		Cement Bentonite (3-5%) Grout	Stop drilling at 15 ft, boring open 5-15 ft, no water present after waiting 30 minutes
7025.0	16												
7024.0	17									At 17 ft: increased hardness		Casing - Schedule 40 PVC, 2" dia.	Moderate drilling
7023.0	18												
7022.0	19												
7021.0	20	Run 4											
7020.0	21												
7019.0	22												
7018.0	23											Stainless Steel Centralizer	
7017.0	24										MINE WASTE		
7016.0	25	12:19 11:42											Stop drilling at 25 ft, boring open 5-25 ft, no water present after waiting 15 minutes
7015.0	26												
7014.0	27												
7013.0	28									LEAN CLAY (CL): light bluish gray (7/5B), moist, ~90% fines, ~10% fine angular sand, medium plasticity, firm			
7012.0	29												
7011.0	30	Run 5											
7010.0	31												
7009.0	32												
7008.0	33												

amec

See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-39 (CONT.)

Monitoring Well / Piezometer ID:PZ-39 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
										LEAN CLAY (CL): continued	MINE WASTE	Cement Bentonite (3-5%) Grout	
7007.0	34	Run 6								LEAN CLAY with SAND (CL): yellow (10YR 8/1), moist, ~80% fines, ~20% fine to coarse angular sand, low plasticity, soft			
7006.0	35	11:48 13:08											Stop drilling at 35 ft, boring open 28-35 ft, no water present after waiting 15 minutes
7005.0	36									SANDY LEAN CLAY (CL): light bluish gray (7/5B), moist, ~90% fines, ~10% fine angular sand, medium plasticity, firm		Casing - Schedule 40 PVC, 2" dia.	
7004.0	37												
7003.0	38												
7002.0	39												
7001.0	40												
7000.0	41												
6999.0	42									At 42-43.5 ft: boulder			
6998.0	43									LEAN CLAY with SAND (CL): yellow (10YR 8/1), moist, ~80% fines, ~20% fine to coarse angular sand, low plasticity, soft			
6997.0	44												
6996.0	45	13:17 14:03								SANDY LEAN CLAY (CL): light bluish gray (7/5B), moist, ~90% fines, ~10% fine angular sand, medium plasticity, firm			Stop drilling at 45 ft, boring open 28-45 ft, no water present after waiting 15 minutes
6995.0	46	Run 7											
6994.0	47									LEAN CLAY with SAND (CL): yellow (10YR 8/1), moist, ~80% fines, ~20% fine to coarse angular sand, low plasticity, soft			
6993.0	48												
6992.0	49									LEAN CLAY (CL): light bluish gray (7/5B), moist, ~90% fines, ~10% fine angular sand, medium plasticity, firm			
6991.0	50												
6990.0	51												
6989.0	52												

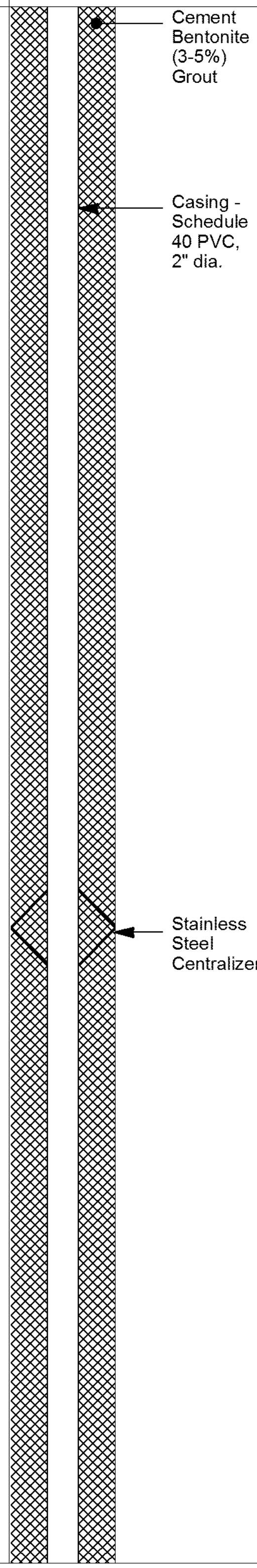
See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
										CLAYEY SAND (SC): pink (5YR 7/3), moist, ~60% fine to medium sand, ~40% nonplastic fines, low toughness		
6988.0	53											
6987.0	54											
6986.0	55	14:13 15:05								SANDY LEAN CLAY (CL): multicolored gray (5YR 6/1), and yellowish red (5YR 5/8), moist, ~70% fines, ~25% fine to medium sand,~5% fine angular gravel, medium plasticity, low toughness		Stop drilling at 55 ft, boring open 38-55 ft, no water present after waiting 15 minutes
6985.0	56											
6984.0	57											
6983.0	58									SANDY LEAN CLAY (CL): yellow (10YR 8/6), and white (10YR 8/1), moist, ~50% fines, ~40% fine to medium sand, ~10% fine gravel, nonplastic, medium toughness, friable, poorly cemented		
6982.0	59											
6981.0	60	Run 8								SANDY LEAN CLAY (CL): light greenish gray (7/10G), yellowish brown (10YR 5/8), white (8/N), moist, ~70% fines, ~25% fine to medium sand, ~5% fine gravel, medium plasticity, hard, clay matrix		
6980.0	61										MINE WASTE	
6979.0	62											
6978.0	63											
6977.0	64											
6976.0	65	15:12 15:59										Stop drilling at 65 ft, boring open 48-65 ft, no water present after waiting 15 minutes
6975.0	66											
6974.0	67											
6973.0	68											
6972.0	69											
6971.0	70	Run 9								At 70 ft: bluish gray mottled with weak red (10R 5/2), yellowish brown (10YR 5/8)		

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-39 (CONT.)

Monitoring Well / Piezometer ID:PZ-39 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
										SANDY LEAN CLAY (CL): continued	MINE WASTE		
6970.0	71											Cement Bentonite (3-5%) Grout	
6969.0	72												
6968.0	73											Casing - Schedule 40 PVC, 2" dia.	
6967.0	74												
6966.0	75	16:08 / 16:14											Stop drilling at 75 ft, boring open 58-75 ft, no water present after waiting 20 minutes
6965.0	76												
6964.0	77												
6963.0	78												
6962.0	79												
6961.0	80	Run 10											
6960.0	81												
6959.0	82												
6958.0	83												
6957.0	84				▼								Static depth to water measured after piezometer completion on 11/17/11.
6956.0	85	16:51 / 10:95											10/11/11 / 10/12/11 Stop drilling at 85 ft, boring open 68-85 ft, no water present after letting boring sit overnight
6955.0	86												
6954.0	87												
6953.0	88												

See explanation sheet for descriptions of codes and symbols.

amec

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
										SANDY LEAN CLAY (CL): continued	MINE WASTE	Cement Bentonite (3-5%) Grout	
6951.0	90	Run 11											
6950.0	91												
6949.0	92											Casing - Schedule 40 PVC, 2" dia.	
6948.0	93												
6947.0	94											Hydrated Medium Bentonite Chip Seal	
6946.0	95	10:55 / 11:46											Stop drilling at 95 ft, boring open 78-95 ft, no water present after waiting 10 minutes.
6945.0	96												
6944.0	97												
6943.0	98												
6942.0	99									SANDY LEAN CLAY (CL): yellow (10YR 7/6), moist, ~55% fines, ~45% fine to coarse subangular sand, nonplastic			
6941.0	100	Run 12								LEAN CLAY (CL): bluish gray, light greenish gray (7/10G) and weak red (10YR 5/2) staining, mottled with yellow (10YR 8/6), ~90% fines, ~10% fine subangular sand, low to medium plasticity, medium to high toughness, wood fragments observed At 101.5 ft: no reaction to HCl			
6940.0	101											#2/12 Sand Filter Pack	
6939.0	102												
6938.0	103											Stainless Steel Centralizer	
6937.0	104									CLAYEY GRAVEL with SAND (GC): very dark greenish gray (3/N), ~60% rounded cobbles, gravel, and pebbles ranging in size from 1/4 inch to 4 inches, ~25% fines, ~15% fine to medium sand, low plasticity, slow dilatancy, low toughness, no reaction to HCl	NATIVE SOIL	Screen - Schedule 40 PVC, 2" dia. with 0.020" machine slots	
6936.0	105	12:00 / 13:03			∇								Stop drilling at 105 ft, boring open 88-105 ft, no water present after waiting 27 minutes
6935.0	106												
6934.0	107											Stainless Steel Centralizer	

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-39 (CONT.)

Monitoring Well / Piezometer ID:PZ-39 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
6933.0	108									CLAYEY GRAVEL with SAND (GC): continued		End Cap - Schedule 40 PVC, 2" dia., with drain hole	
6932.0	109	Run 13					Lo	Fr	Se	LAHAR: gray (7/10B), moist, ~95% fines, ~5% fine sand, moderate reaction with HCl, poorly indurated, altered, contains a clay-lined root cast	BEDROCK		
6931.0	110												
6930.0	111												
6929.0	112											Hydrated Medium Bentonite Chips	
6928.0	113												
6927.0	114												
6926.0	115	13:11 / 14:25											Stop drilling at 115 ft, boring open 98-115 ft, DTW = 83.4 ft. Collect grab groundwater sample SBL10121101 using a disposable bailer
6925.0	116	Run 14											
6924.0	117												
6923.0	118												
6922.0	119						Mo-Ha	Fr	Se	SANDSTONE: light blue gray (7/5B), moist, clast supported, medium to coarse angular sand-sized clasts, ~60% bluish volcanic clasts, ~40% gray fine-grained matrix, clasts includes lithic fragments containing andesite, hornblende, biotite, zones of chloritization, moderate reaction with HCl, moderately indurated, severely altered			
6921.0	120												
6920.0	121	14:23											
6919.0	122												
6918.0	123												
6917.0	124												
6916.0	125	14:43 / 16:00											

See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-39 (CONT.)
Monitoring Well / Piezometer ID:PZ-39 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		Run 15					Mo-Ha	Fr	Se	SANDSTONE: continued	BEDROCK	Hydrated Medium Bentonite Chips	
6914.0	127												
6913.0	128	16:20								Bottom of boring at 128.0 ft bgs			Stop drilling at 128 ft, boring open 110-128 ft, DTW = 82.8 ft. Collect grab groundwater sample SBL10131102 using a disposable bailer
6912.0	129												
6911.0	130												
6910.0	131												
6909.0	132												
6908.0	133												
6907.0	134												
6906.0	135												
6905.0	136												
6904.0	137												
6903.0	138												
6902.0	139												
6901.0	140												
6900.0	141												
6899.0	142												
6898.0	143												
6897.0	144												

amec

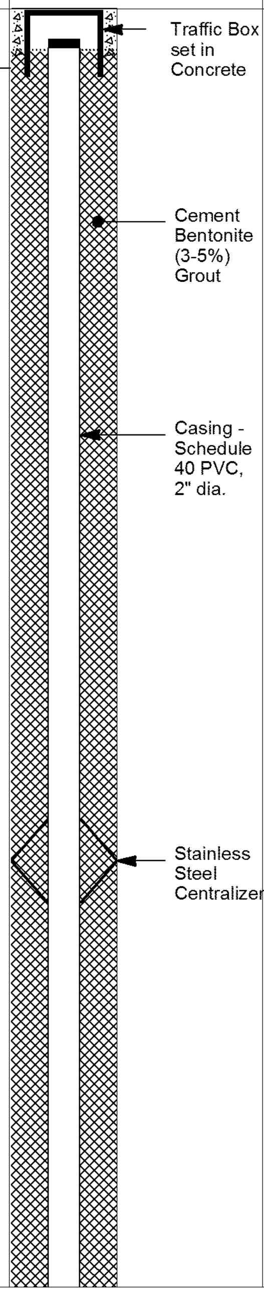
See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT:	LEVIATHAN MINE SITE Alpine County, California	**Log of Boring No.B-65**	
CLIENT:	Atlantic Richfield Company	**Monitoring Well / Piezometer ID:PZ-44**	
BORING LOCATION:	LCSA	ELEVATION (feet) 7041.14	NORTHING/EASTING 2026608.33 N / 7228363.51 E
DRILLING CONTRACTOR:	Cascade Drilling, L.P.	DATE STARTED: 9/26/2012	DATE FINISHED: 9/28/2012
DRILLING EQUIPMENT:	Geoprobe 8140 LS track-mounted rig	TOTAL DEPTH (feet): 45	MEASURING POINT: Ground surface
DRILLING METHOD:	Sonic	DEPTH TO WATER (FIRST / COMPLETION): Dry / 21.11 feet	
SAMPLING METHOD:	4" Sonic core tool	SCREEN INTERVAL (feet): 21.5-26.0	TOC ELEVATION (feet): 7040.76
BOREHOLE DIAMETER:	6" (0-36.5') / 4" (36.5-45')	LOGGED BY: A. Burkemper	REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
	0	Run 1 (14:34–14:37)								SILTY GRAVEL with SAND (GM): mottled pinkish white (7.5YR 8/2), gray (N 6/), dry, ~60% fine angular gravel, ~20% fine to coarse angular sand, ~20% fines, gravel is very hard and silicious, very loose	FILL	Begin drilling at 14:34
7040.1	1									LEAN CLAY with GRAVEL (CL): mottled grayish brown (2.5Y 5/2), light greenish gray (10GY 7/1) and yellowish brown (10YR 5/6), moist, ~80% fines, ~15% fine to coarse angular gravel, ~5% fine to coarse sand, low plasticity, stiff to very stiff	MINE WASTE	
7039.1	2											
7038.1	3	Run 2 (14:39–14:43)										
7037.1	4											
7036.1	5	Run 3 (14:46–14:50)										
7035.1	6											
7034.1	7											
7033.1	8	Run 4 (14:52–14:56)										
7032.1	9											
7031.1	10	Run 5 (15:08–15:12)								LEAN CLAY with GRAVEL (CL): mottled grayish brown (2.5Y 5/2), light greenish gray (10GY 7/1), yellowish brown (10YR 5/6), moist, ~80% fines, ~15% fine to coarse angular gravel, ~5% fine to coarse sand, low plasticity, stiff to very stiff, trace roots, some iron oxide staining		
7030.1	11											
7029.1	12											
7028.1	13											
7027.1	14											
7026.1	15											

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-65 (CONT.)
Monitoring Well / Piezometer ID:PZ-44 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		15:15 R6 15:22								LEAN CLAY with GRAVEL (CL): continued	MINE WASTE	Cement Bentonite (3-5%) Grout	Stop drilling at 15 ft, boring open 0-15 ft, no water present.
7025.1	16	15:25 R7 15:34											
7024.1	17	15:37 15:44 16:21								At 17-18 ft: some pinkish white (7.5YR 8/2), very hard, very strong, silicious gravel and cobbles		Casing - Schedule 40 PVC, 2" dia.	
7023.1	18	Run 9										Hydrated Medium Bentonite Chip Seal	
7022.1	19												
7021.1	20	16:23 16:26								GRAVELLY LEAN CLAY (CL): very dark gray (2.5Y 3/1), moist, ~65% fines, ~25% fine to coarse angular gravel, ~10% fine to medium sand, medium plasticity, stiff to very stiff, some roots and organics	NATIVE SOIL	#60 Transition Sand	
7020.1	21	Run 10	SBL09261201		▼							Stainless Steel Centralizer	Static depth to water measured after piezometer completion on 10/5/12.
7019.1	22											#2/12 Sand Filter Pack	
7018.1	23									At 23 ft: dark grayish brown (10YR 4/2), trace rootlets			
7017.1	24											Screen - Schedule 40 PVC, 2" dia. with 0.020" machine slots	
7016.1	25	16:31 10:42											9/26/12 9/27/12
7015.1	26											Stainless Steel Centralizer	Stop drilling at 25 ft, boring open 15-25 ft, no water present after waiting overnight.
7014.1	27	Run 11							Se	BASALT (Trb): grayish orange pink (5YR 7/2), moist, clasts are weathered to ~50% coarse to very fine subangular sand, ~45% fines, ~5% mostly fine angular gravel, non plastic, slow dilatancy, severely to completely altered, relict basalt structure	BEDROCK	End Cap - Schedule 40 PVC, 2" dia., with drain hole	
7013.1	28												
7012.1	29												
7011.1	30	10:58 11:22										Hydrated Medium Bentonite Chips	Stop drilling at 30 ft, boring open 20-30 ft, no water present.
7010.1	31	Run 12											
7009.1	32	11:30 11:39											
7008.1	33	R13								At 33 ft: increasing gravel-sized clast content, ~45% sand, ~35-40% fines,			

amec

See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company	**Log of Boring No.B-65 (CONT.)** **Monitoring Well / Piezometer ID:PZ-44 (CONT.)**

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
7007.1	34	Run 13								BASALT (Trb): continued ~15-20% gravel, gravel appears to be severely weathered	BEDROCK	Hydrated Medium Bentonite Chips	
7006.1	35	11:44 12:40								At 35 ft: slightly weathered, ~3-inch diameter basalt clast			
7005.1	36	Run 14											
7004.1	37									At 37.5 ft: moist			
7003.1	38	12:53 14:42											
7002.1	39	Run 15											
7001.1	40	14:44 14:52								At 40 ft: grayish orange pink (5YR 7/2), moist, clasts are weathered to ~50% coarse to very fine angular to subangular sand, ~40-45% medium plasticity fines, ~5-10% mostly fine angular gravel, medium plasticity, gravel clasts appear to have completely altered basalt texture			
7000.1	41												
6999.1	42	Run 16											
6998.1	43												
6997.1	44												
6996.1	45	15:00								Bottom of boring at 45 ft bgs			Stop drilling at 45 ft, boring open 20-45 ft, no water present.
6995.1	46												
6994.1	47												
6993.1	48												
6992.1	49												
6991.1	50												
6990.1	51												
6989.1	52												

amec

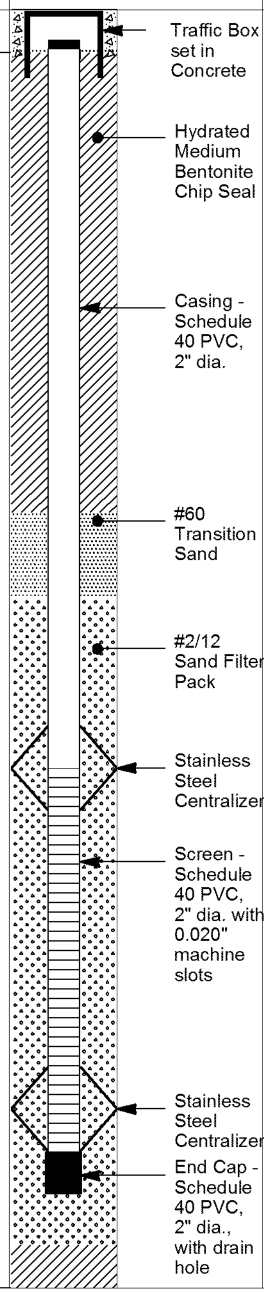
See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE, Alpine County, California CLIENT: Atlantic Richfield Company	**Log of Boring No.B-65S** **Monitoring Well / Piezometer ID:PZ-45**	
BORING LOCATION: LCSA	ELEVATION (feet): 7041.10	NORTHING/EASTING: 2026617.07 N / 7228354.98 E
DRILLING CONTRACTOR: Cascade Drilling, L.P.	DATE STARTED: 10/1/2012	DATE FINISHED: 10/2/2012
DRILLING EQUIPMENT: Geoprobe 8140 LS track-mounted rig	TOTAL DEPTH (feet): 25	MEASURING POINT: Ground surface
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): Dry / 13.05 feet	
SAMPLING METHOD: 4" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 8.9-13.4	TOC ELEVATION (feet): 7040.79
BOREHOLE DIAMETER: 6" (0-20') / 4" (20-25')	LOGGED BY: A. Burkemper	REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
	0	13:27 Run 1								SILTY GRAVEL with SAND (GM): mottled pinkish white (7.5YR 8/2) and gray (N 6/), dry, ~60% fine angular very hard siliceous gravel, ~20% fine to coarse angular sand, ~20% fines, very loose	FILL	Begin drilling at 13:27
7040.1	1									LEAN CLAY with GRAVEL (CL): mottled grayish brown (2.5Y 5/2), light greenish gray (10GY 7/1), pale red (10R 6/2) and yellowish brown (10YR 5/6), moist, ~85% fines, ~10% fine to medium angular to subangular gravel, ~5% fine to coarse sand, low plasticity, stiff to very stiff, trace roots	MINE WASTE	
7039.1	2	13:30 / 13:33 Run 2										
7038.1	3											
7037.1	4											
7036.1	5	13:36 / 13:38 Run 3										
7035.1	6											
7034.1	7	13:39 / 13:42 Run 4										
7033.1	8											
7032.1	9											
7031.1	10	13:44 / 13:48 Run 5	SBL10011203									
7030.1	11											
7029.1	12											
7028.1	13				▼					At 12.8-13.2 ft: increased gravel content, up to 2.5-inch diameter, iron oxide staining At 13.2 ft: little to some roots		Static depth to water measured after piezometer completion on 10/5/12.
7027.1	14											
7026.1	15	13:50										

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		14:31								LEAN CLAY with GRAVEL (CL): continued At 15 ft: mostly black, some roots and organics	NATIVE SOIL	Hydrated Medium Bentonite Chips	Blowcounts 15-15.5 ft: 8 15.5-16 ft: 6 16-16.5 ft: 10
7025.1	16	Run 6	SBL10011201										
7024.1	17									At 17.5 ft: dark gray (10YR 4/1)			
7023.1	18												
7022.1	19								Se	BASALT (Trb): grayish orange pink (5YR 7/2), moist, clasts weathered to ~50% coarse to very fine angular to subangular sand, ~35-40% fines, ~10-15% mostly fine (< 1-inch diameter) subangular gravel, medium plasticity, clasts appear to be highly to completely altered basalt	BEDROCK		
7021.1	20	14:36 / 09:23											10/1/12 / 10/2/12
7020.1	21	Run 7	SBL10011202										Blowcounts 20-20.5 ft: 10 20.5-21 ft: 25 21-21.5 ft: 50
7019.1	22	09:28 / 09:43											
7018.1	23												
7017.1	24	Run 8											
7016.1	25	09:45								Bottom of boring at 25 ft bgs			
7015.1	26												
7014.1	27												
7013.1	28												
7012.1	29												
7011.1	30												
7010.1	31												
7009.1	32												
7008.1	33												

See explanation sheet for descriptions of codes and symbols.

amec

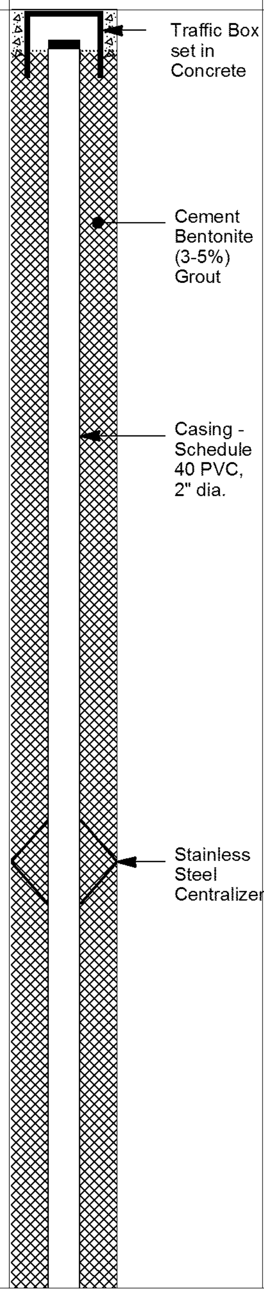
Project No. 13091

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company		**Log of Boring No.B-67** **Monitoring Well / Piezometer ID:PZ-47**	
BORING LOCATION:	LCSA	ELEVATION (feet) 7041.42	NORTHING/EASTING 2026782.46 N / 7228641.14 E
DRILLING CONTRACTOR:	Cascade Drilling, L.P.	DATE STARTED: 10/3/2012	DATE FINISHED: 10/15/2012
DRILLING EQUIPMENT:	Geoprobe 8140 LS track-mounted rig	TOTAL DEPTH (feet): 141	MEASURING POINT: Ground surface
DRILLING METHOD:	Sonic	DEPTH TO WATER (FIRST / COMPLETION): Dry / Dry	
SAMPLING METHOD:	4" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 87.0-96.6	TOC ELEVATION (feet): 7040.95
BOREHOLE DIAMETER:	6" (0-100') / 4" (100-141')	LOGGED BY: J. Gonzales	REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
	0	12:45 Run 1		SILTY GRAVEL with SAND (GM): pinkish white (7.5YR 8/2), dry, ~60% fine to coarse subangular gravel, ~20% fines, ~20% fine to coarse sand, very loose	MINE WASTE	Begin drilling at 12:45 Soil sample SBL10161201 collected from 0-0.5 ft.
7040.4	1			GRAVELLY LEAN CLAY (CL): grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6), moist, ~70% fines, ~20% fine to coarse subrounded to subangular gravel, ~10% fine to coarse sand, low plasticity, stiff to very stiff		
7039.4	2		SBL10161204			Soil sample SBL10161202 collected from 2-2.5 ft. Grab soil samples (0-6 ft) collected from companion boring advanced ~10 ft east of original boring.
7038.4	3	12:52 / 12:55 Run 2				
7037.4	4		SBL10161205			
7036.4	5	12:56 / 12:58 Run 3		At 5.5 ft: cobble		Soil sample SBL10161203 collected from 5-5.5 ft.
7035.4	6					
7034.4	7	13:02 / 13:04 Run 4		At 7.5-10.5 ft: light brownish gray (2.5Y 6/2)		
7033.4	8					
7032.4	9					
7031.4	10	13:07 / 13:14 Run 5		At 10.5-12 ft: strong brown (7.5YR 5/8)		
7030.4	11					
7029.4	12	13:19 / 13:29 Run 6		At 12-15 ft: pale green (5GY 6/2)		
7028.4	13					
7027.4	14					
7026.4	15	13:33				

Columns also printed (no entries): SAMPLE & RECOVERY, DEPTH TO WATER, FRACTURING, HARDNESS, STRENGTH, WEATHERING.

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		13:35								SANDY LEAN CLAY with GRAVEL (CL): grayish brown (2.5Y 5/2) to light brownish gray (2.5Y 6/2), ~60% fines, ~20% fine to coarse subrounded to subangular sand, ~20% fine to coarse subrounded to subangular gravel, low plasticity, stiff, occasional coarse gravel sized breccia, dark bluish gray (5B 4/1)	MINE WASTE	Cement Bentonite (3-5%) Grout	
7025.4	16	Run 7											
7024.4	17	13:39										Casing - Schedule 40 PVC, 2" dia.	
		13:40											
7023.4	18												
7022.4	19	Run 8											
7021.4	20	13:44											
		13:47								At 20 ft: decreasing gravel content			
7020.4	21												
7019.4	22												
7018.4	23	Run 9											
7017.4	24												
7016.4	25	13:52											
		13:56								SANDY LEAN CLAY (CL): grayish brown (2.5Y 5/2), moist, ~70% fines, ~25% fine to coarse sand, ~5% fine subangular gravel, low plasticity, stiff to very stiff At 25.5-27 ft: medium stiff			
7015.4	26												
7014.4	27	Run 10											
7013.4	28									At 28-29 ft: medium stiff			
7012.4	29												
7011.4	30	14:00											
		14:51								At 30 ft: ~70% fines, ~20% fine to coarse sand, ~10% fine to coarse subangular to subrounded gravel			
7010.4	31												
7009.4	32	Run 11											
7008.4	33												

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-67 (CONT.)
Monitoring Well / Piezometer ID:PZ-47 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
7007.4	34	Run 11								SANDY LEAN CLAY (CL): continued		Cement Bentonite (3-5%) Grout	
7006.4	35	14:54 / 15:03								At 35 ft: grayish brown (2.5Y 5/2) and light yellowish brown (2.5Y 6/4)		Casing - Schedule 40 PVC, 2" dia.	
7005.4	36												
7004.4	37	Run 12								GRAVELLY LEAN CLAY with SAND (CL): light gray (7.5YR 7/1), moist, ~65% fines, ~20% fine to coarse subangular gravel, ~15% fine to coarse sand, medium stiff			
7003.4	38												
7002.4	39									At 38.75 ft: decreasing sand content			
										SANDY LEAN CLAY (CL): moist, ~70% fines, ~25% fine to coarse sand, ~5% subangular gravel, low plasticity, stiff to very stiff			
7001.4	40	15:08 / 15:46											
7000.4	41									SANDY LEAN CLAY with GRAVEL (CL): greenish gray (10Y 6/1), moist, ~65% fines, ~20% fine to coarse sand, ~15% fine to coarse subangular gravel, low plasticity, stiff to very stiff			Driller notes alternating hard and soft drilling conditions from 40 to 45 ft.
6999.4	42	Run 13											
6998.4	43									LEAN CLAY with SAND (CL): light reddish brown (5YR 6/3) and brownish yellow (10YR 6/6), moist, ~85% fines, ~10% fine to coarse sand, ~5% fine subangular gravel, low plasticity, stiff to very stiff	MINE WASTE		
6997.4	44												
6996.4	45	15:52 / 16:00								SANDY LEAN CLAY (CL): reddish yellow (7.5YR 6/6) and light greenish gray (5G 7/1), moist, ~70% fines, ~20% fine to coarse sand, ~10% fine subangular gravel, low plasticity, stiff to very stiff		Stainless Steel Centralizer	
6995.4	46												
6994.4	47	Run 14											
6993.4	48												
6992.4	49									At 49 ft: some reddish brown (2.5YR 5/4) zones			
6991.4	50	16:05 / 10:47	SBL10041202							SANDY LEAN CLAY with GRAVEL (CL): light greenish gray (5G 7/1) with some zones of reddish yellow (7.5YR 6/8) in upper 1.5 feet, moist, ~65% fines, ~20% fine to coarse sand, ~15% fine to coarse subrounded gravel, low plasticity, stiff			10/03/12 / 10/04/12
6990.4	51	Run 15											Stop drilling at 50 ft, boring open 30-50 ft, no water present after waiting overnight.
6989.4	52												

See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-67 (CONT.)

Monitoring Well / Piezometer ID:PZ-47 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
										SANDY LEAN CLAY with GRAVEL (CL): continued At 51.5-51.7 ft: lens of increased fines, light brownish gray (2.5Y 6/2)	MINE WASTE	Cement Bentonite (3-5%) Grout	
6988.4	53	Run 15								LEAN CLAY with SAND (CL): light greenish gray (5G 7/1), moist, ~80% fines, ~10% fine to coarse sand, ~10% subangular gravel, low plasticity, stiff to very stiff			
6987.4	54												
6986.4	55	10:53 11:24								SANDY LEAN CLAY with GRAVEL (CL): light greenish gray (5G 7/1) with some light brownish gray (2.5Y 6/2) zones, ~60% fines, ~25% fine to coarse subangular sand, ~15% fine to coarse subrounded to subangular gravel, low plasticity, slow dilatancy, stiff, medium dry strength		Casing - Schedule 40 PVC, 2" dia.	
6985.4	56												
6984.4	57	Run 16											
6983.4	58									LEAN CLAY with SAND (CL): reddish gray (5YR 5/2), moist, ~80% fines, ~10% fine to coarse sand, ~10% subangular gravel, low plasticity, stiff to very stiff			
6982.4	59												
6981.4	60	11:29 13:04								SANDY LEAN CLAY with GRAVEL (CL): light greenish gray (5G 7/1) and light brownish gray (2.5Y 6/2), ~60% fines, ~25% fine to coarse subangular sand, ~15% fine to coarse subrounded to subangular gravel, low plasticity, slow dilatancy, stiff, medium dry strength			
6980.4	61												
6979.4	62	Run 17								LEAN CLAY with SAND (CL): light greenish gray (5G 7/1) with zones of yellow (10YR 7/6), ~80% fines, ~10% fine to coarse sand, ~10% subangular gravel, low plasticity, none to slow dilatancy, very stiff, medium to high dry strength			
6978.4	63												
6977.4	64												
6976.4	65	13:09 13:21								SANDY LEAN CLAY with GRAVEL (CL): light greenish gray (5G 7/1) to greenish gray (5G 6/1), moist, ~60% fines, ~25% fine to coarse sand, ~15% fine to coarse gravel, low plasticity, stiff			
6975.4	66	Run 18											
6974.4	67	13:33 13:44											
6973.4	68	Run 19											
6972.4	69									At 69 ft: sulfur crystal			Stop drilling at 70 ft, boring open 60-70 ft, no water present after waiting 15 minutes.
6971.4	70	13:46 15:08								At 70 ft: zones of very dark greenish gray (5G 3/1)			

amec

See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

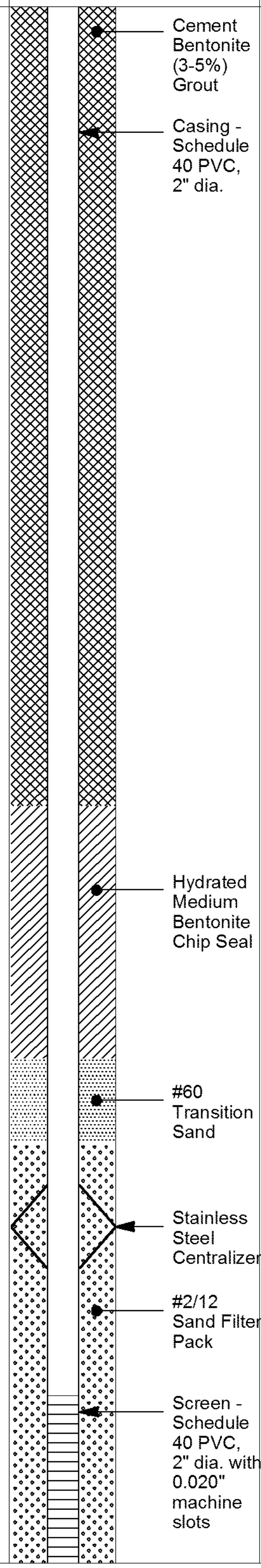
CLIENT: Atlantic Richfield Company

Log of Boring No.B-67 (CONT.)

Monitoring Well / Piezometer ID:PZ-47 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
6970.4–6966.4	71–75	Run 20 (to 15:12)								SANDY LEAN CLAY with GRAVEL (CL): continued At 73 ft: ~60% fines, ~20% fine to coarse sand, ~20% fine to coarse subangular gravel	MINE WASTE	
6966.4–6964.4	75–77	15:25 Run 21 15:30										
6964.4–6961.4	77–80	15:42 Run 22 15:48								LEAN CLAY with SAND (CL): light brown (7.5YR 6/3) and light greenish gray (5G 7/1), moist, ~80% fines, ~10% fine to coarse sand, ~10% fine to coarse subangular gravel, low plasticity, very stiff		
6961.4–6956.4	80–85	09:27 Run 23 09:32								SANDY LEAN CLAY with GRAVEL (CL): light greenish gray (10GY 7/1), moist, ~60% fines, ~20% fine to coarse sand, ~20% fine to coarse subangular gravel, low plasticity, stiff LEAN CLAY (CL): light greenish gray (5G 8/1), moist, ~90% fines, ~5% fine to coarse sand, ~5% fine gravel, low plasticity, stiff to very stiff SANDY LEAN CLAY with GRAVEL (CL): light greenish gray (10GY 7/1), moist, ~60% fines, ~20% fine to coarse sand, ~20% fine to coarse subangular gravel At 84-84.5 ft: light gray (N 7/), increased gravel sized grain content		10/04/12 10/05/12 Stop drilling at 80 ft, boring open 70-80 ft, no water present after waiting overnight.
6956.4–6953.4	85–88	10:01 Run 24					Mo			LEAN CLAY with SAND (CL): light greenish gray (10Y 7/1) to dark gray (2.5Y 4/1), moist, ~75% fines, ~15% fine to coarse sand, ~10% fine to coarse subangular gravel, low plasticity, stiff to very stiff At 87-89 ft: light gray (N 7/), dry, angular to subangular cobbles and broken cobbles, sulfide bearing		Driller reports cobbles at 87 ft.

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

Log of Boring No.B-67 (CONT.)

Monitoring Well / Piezometer ID:PZ-47 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
6951.4	90	R 24 10:06 12:46								SANDY LEAN CLAY with GRAVEL (CL): light greenish gray (5G 7/1) to greenish gray (5G 6/1), moist, ~60% fines, ~20% fine to coarse sand, ~20% fine to coarse subangular gravel, low plasticity, stiff SANDY LEAN CLAY with GRAVEL (CL): dark grayish brown (10YR 4/2), moist, ~60% fines, ~25% fine to medium sand, ~15% fine to coarse subangular gravel, low plasticity, slow dilatancy, stiff At 90 ft: piece of wood At 90-90.25 ft: very dark grayish brown (2.5Y 3/1), occasional rootlets, organics surrounding piece of mine waste	NATIVE SOIL	#2/12 Sand Filter Pack	Stop drilling at 90 ft, boring open 80-90 ft, no water present after waiting 30 minutes.
6950.4	91												
6949.4	92	Run 25										Screen - Schedule 40 PVC, 2" dia. with 0.020" machine slots	
6948.4	93												
6947.4	94		SBL10051202										
6946.4	95	12:54 13:47 13:49 10:06								SANDY LEAN CLAY (CL): dark reddish gray (2.5YR 4/1) to grayish brown (10YR 5/2), moist, ~70% fines, ~20% fine to coarse sand, ~10% fine subrounded to subangular gravel, low plasticity, none to slow dilatancy, medium stiff to stiff, high dry strength, occasional rootlets throughout, no reaction to HCl			10/05/12 10/08/12 Blowcounts 95-95.5 ft: 71/6"
6945.4	96											Stainless Steel Centralizer End Cap - Schedule 40 PVC, 2" dia., with drain hole	Stop drilling at 95 ft, boring open 80-95 ft, no water present after waiting 2 days.
6944.4	97	Run 27					So	Fr	Se	LAHAR: moderate greenish yellow (10Y 7/4) and grayish yellow green (5GY 7/2) with zones of yellowish gray (5Y 8/1), occasional rootlets in upper 2 ft, moderate reaction to HCl, altered and weathered to fines and fine gravel sized material, contains boulders of medium grained volcaniclastic sandstone and breccia clasts	BEDROCK		
6943.4	98												
6942.4	99	10:10 10:31 28										Hydrated Medium Bentonite Chips	Driller reports hard conditions at 99 ft.
6941.4	100	10:35 12:36					Lo	We	Se				Stop drilling at 100 ft, boring open 80-100 ft, no water present after waiting 30 minutes.
6940.4	101												
6939.4	102	Run 29											
6938.4	103						Mo	Mo	Sl	At 103 ft: pale yellowish green (10GY 7/2) to grayish yellow green (5GY 7/2) matrix supported clasts with some remineralization, clasts are medium sand to fine gravel sized, moderate reaction to HCl			
6937.4	104												
6936.4	105	12:46 13:06											
6935.4	106	Run 30					Mo	Mo	Sl				
6934.4	107	13:26 14:35											

See explanation sheet for descriptions of codes and symbols.

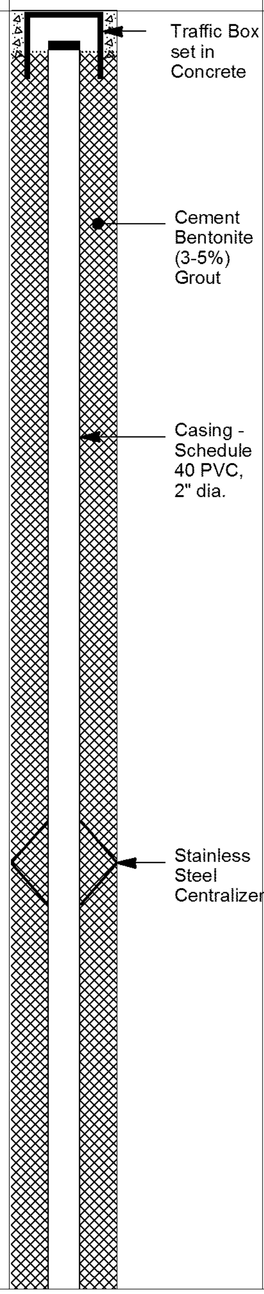
amec

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		14:31								LAHAR: continued			
6933.4	108	14:45 / 15:20										Hydrated Medium Bentonite Chips	Stop drilling at 108 ft, boring open 80-108 ft, no water present after waiting 15 minutes.
6932.4	109	Run 32											
6931.4	110	15:31 / 15:39											
6930.4	111	Run 33											
6929.4	112	15:50 / 16:15											
6928.4	113												
6927.4	114	Run 34											
6926.4	115	16:26 / 09:29											10/08/12 / 10/09/12
6925.4	116	Run 35					Lo	We	Mo-Se	At 116 ft: moderate greenish yellow (10Y 7/4), grayish yellow green (5GY 7/2), yellowish gray (5Y 8/1), some zones of low hardness	BEDROCK	Cement Bentonite Grout	Stop drilling at 115 ft, boring open 80-115 ft, no water present after waiting overnight.
6924.4	117	09:37 / 09:58											
6923.4	118												
6922.4	119	Run 36											
6921.4	120	10:15 / 10:38											
6920.4	121												
6919.4	122												
6918.4	123	Run 37					Lo	We	Se	At 123 ft: moderate greenish yellow (10Y 7/4) to yellowish gray (5Y 7/2)			
6917.4	124												
6916.4	125	10:51 / 13:20					St	Mo	Sl-Mo	At 125 -131 ft: grayish yellow green (5GY 7/2) to greenish gray (5GY 6/1), increased zones of moderately strong,			Stop drilling at 125 ft, boring open 80-125 ft, no water present after waiting 15 minutes.
		R 38											

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
6914.4	127	Run 38								LAHAR: continued moderately hard, slight to moderately weathered bedrock	BEDROCK	Cement Bentonite Grout	
		13:31 / 13:54											
6913.4	128	Run 39					St	Mo	Sl-Mo				
6912.4	129												
6911.4	130	14:03 / 14:37											Stop drilling at 130 ft, boring open 80-130 ft, no water present after waiting 15 minutes.
6910.4	131	Run 40					Lo	We	Se	At 131 ft: moderate greenish yellow (10Y 7/4) to yellowish gray (5Y 7/2)			Driller reports hard drilling from 130-131 ft, followed by easy drilling from 131-134 ft.
6909.4	132												
6908.4	133												
6907.4	134	14:43 / 15:12					St	Mo	Sl-Mo	At 134 ft: increased hardness and strength			
6906.4	135	Run 41											
6905.4	136									At 136.5 ft: volcanic breccia (0.1 ft thick)			
6904.4	137						Lo	We	Se	At 137-138.5 ft: increased weathering			
6903.4	138						St	Mo	Sl-Mo	At 138.5 ft: increased hardness and strength			
6902.4	139	15:28 / 16:06 R42								At 139.5 ft; volcaniclastic sandstone boulder			
6901.4	140	16:15											10/09/12 10/10/12 Stop drilling at 140 ft, boring open 80-140 ft, no water present after waiting overnight.
6900.4	141									Bottom of boring at 141 ft bgs			
6899.4	142												
6898.4	143												
6897.4	144												

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company	Log of Boring No.B-63 Monitoring Well / Piezometer ID:PZ-49	
BORING LOCATION: LCSA	ELEVATION (feet) 7041.37	NORTHING/EASTING 2026329.16 N / 7228617.19 E
DRILLING CONTRACTOR: Cascade Drilling, L.P.	DATE STARTED: 10/16/2012	DATE FINISHED: 10/18/2012
DRILLING EQUIPMENT: Sonic Corp. 50K truck-mounted rig	TOTAL DEPTH (feet): 38	MEASURING POINT: Ground surface
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): NA / Dry	
SAMPLING METHOD: 4" & 6" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 32.8-37.3	TOC ELEVATION (feet): 7041.09
BOREHOLE DIAMETER: 6" (0-38')	LOGGED BY: M. Kairouz	REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
	0	Run 1 (14:45–14:46)								CLAYEY SAND with GRAVEL (SC): grayish brown (2.5Y 5/2), moist, ~30% fine sand, ~25% fines, ~20% fine angular gravel, ~15% medium sand, ~10% coarse sand, sand is subangular to subrounded, medium dense, gravel clasts composed primarily of highly weathered andesite	MINE WASTE		Begin drilling at 14:45
7040.4	1												
7039.4	2									SANDY LEAN CLAY with GRAVEL (CL): mottled light greenish gray (5G 8/1), weak red (10R 5/3), olive yellow (2.5Y 6/6), gray (N 6/), light greenish gray (5GY 8/1), moist, ~50% fines, ~15% fine sand, ~15% fine angular to subangular gravel, ~10% medium sand, ~5% coarse sand, ~5% coarse subangular gravel, sand is subangular to subrounded, low plasticity, no dilatancy, very stiff, high dry strength, gravel fragments are highly weathered and are altered to clay that breaks apart easily At 1.3-2 ft: high sulfur content At 2.7-3.4 ft: iron oxide staining			
7038.4	3												
7037.4	4												
7036.4	5	Run 2 (14:52–14:53)											
7035.4	6												
7034.4	7												
7033.4	8												
7032.4	9												
7031.4	10	Run 3 (15:35–15:36)											
7030.4	11												
7029.4	12									At 12 ft: less gravel At 12.4-12.7 ft: orange iron oxide staining			
7028.4	13									SANDY LEAN CLAY (CL): mottled dark gray (5Y 4/1) and greenish gray (10Y 6/1), ~65% fines, ~25% fine sand, ~10% fine subangular gravel, low plasticity, no dilatancy, soft, high dry strength, contains bark, pine needles, branches, wood pieces, moderate hydrocarbon odor			
7027.4	14												
7026.4	15												



See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-63 (CONT.)

Monitoring Well / Piezometer ID:PZ-49 (CONT.)

ELEVATION (feet)	DEPTH (feet)
7025.4	16
7024.4	17
7023.4	18
7022.4	19
7021.4	20
7020.4	21
7019.4	22
7018.4	23
7017.4	24
7016.4	25
7015.4	26
7014.4	27
7013.4	28
7012.4	29
7011.4	30
7010.4	31
7009.4	32
7008.4	33

RUN: Run 4 (15:53 – 15:54); Run 5 (10:06 – 10:06); Run 6 (10:16 – 10:16); Run 7 (11:00 – 11:00); Run 8 (11:08 – 11:08); Run 9 (13:01 – 13:01); Run 10 (13:20 –)

SAMPLE NUMBER: SBL10171201 (Run 7); SBL10171203 (Run 9)

FRACTURING: Cl | HARDNESS: So, Mo | STRENGTH: Fr, Mo | WEATHERING: Se, Sl

LITHOLOGIC DESCRIPTION

SANDY LEAN CLAY (CL): continued

SANDY LEAN CLAY (CL): mottled brown (7.5YR 5/4), light greenish gray (10Y 7/1) and gray (N 5/), moist, ~55% fines, ~30% fine sand, ~10% medium sand, ~5% angular fine gravel, sand is angular to subrounded, low plasticity, no dilatancy, hard, high dry strength

At 20.4-21 ft: mottled gray (10YR 5/1) and grayish brown (10YR 5/2)
At 20.8 ft: large piece of wood

At 21.5-23.2 ft: cobble zone composed of silicified breccia with sulfur crystals and dark gray ore rock

LEAN CLAY (CL): gray (5Y 6/1), moist, ~85% fines, ~10% fine sand, ~5% medium sand, sand is subangular, medium plasticity, no dilatancy, medium stiff, medium dry strength

At 25-26.5 ft: gray (10YR 5/1), ~20% sand

At 26.5-27.5 ft: altered tuff cobble, light greenish gray (5GY 7/1), altered to clay

SANDY LEAN CLAY (CL): black (10YR 2/1) grading to very dark brown (10YR 2/2) at 29.5 ft, ~65% fines, ~35% fine subangular to rounded sand, composed of red-brown, rounded volcanic grains, quartz crystals and black andesite grains, low plasticity, slow dilatancy, very stiff, high dry strength, contains twigs, grasses, wood, roots
At 30.1-30.5 ft: mottled clayey transition zone to weathered bedrock

BASALT (Trb): moderate brown (5YR 3/4) and light brown (5YR 5/6), contains roots, twigs and small root hairs, dry
At 30.5-31.8 ft: iron oxide staining pervasive into rock, clay alteration, no reaction with HCl

At 32.5 ft: less altered

GEOLOGIC MATERIAL

MINE WASTE

NATIVE SOIL

BEDROCK

WELL SCHEMATIC

Cement Bentonite (3-5%) Grout

Casing - Schedule 40 PVC, 2" dia.

Hydrated Medium Bentonite Chip Seal

#60 Transition Sand

#2/12 Sand Filter Pack

Stainless Steel Centralizer

REMARKS

10/16/12
10/17/12
Stop drilling at 20.4 ft, boring open 20-20.4 ft, no water present after waiting overnight.

Stop drilling at 30 ft, boring open 20-30 ft, no water present after waiting 50 minutes.

See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

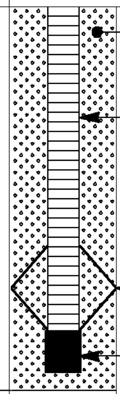
CLIENT: Atlantic Richfield Company

Log of Boring No.B-63 (CONT.)

Monitoring Well / Piezometer ID:PZ-49 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
7007.4	34	Run 10								BASALT (Trb): continued At 33 ft: medium bluish gray (5B 5/1), dry, aphanitic groundmass with plagioclase crystals	BEDROCK	
7006.4	35	13:26 13:50										
7005.4	36	Run 11										
7004.4	37	13:55										Stop drilling at 36.8 ft, boring open 20-36.8 ft, no water present after waiting 25 minutes.
7003.4	38									Bottom of boring at 38 ft bgs		
7002.4	39											
7001.4	40											
7000.4	41											
6999.4	42											
6998.4	43											
6997.4	44											
6996.4	45											
6995.4	46											
6994.4	47											
6993.4	48											
6992.4	49											
6991.4	50											
6990.4	51											
6989.4	52											

WELL SCHEMATIC



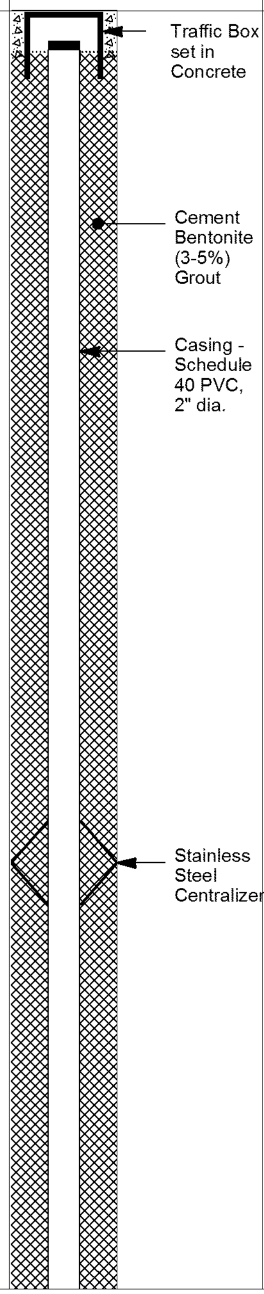
See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company	**Log of Boring No.B-63S** **Monitoring Well / Piezometer ID:PZ-50**
BORING LOCATION: LCSA	ELEVATION (feet): 7041.32 / NORTHING/EASTING: 2026337.86 N / 7228614.49 E
DRILLING CONTRACTOR: Cascade Drilling, L.P.	DATE STARTED: 10/18/2012 / DATE FINISHED: 10/19/2012
DRILLING EQUIPMENT: Sonic Corp. 50K truck-mounted rig	TOTAL DEPTH (feet): 28.5 / MEASURING POINT: Ground surface
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): NA / Dry
SAMPLING METHOD: 4" & 6" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 21.1-25.7 / TOC ELEVATION (feet): 7041.07
BOREHOLE DIAMETER: 6" (0-28.5')	LOGGED BY: M. Kairouz / REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
	0	11:49								CLAYEY SAND (SC): grayish brown (2.5Y 5/2), dry, ~30% fines, ~30% fine sand, ~20% medium sand, ~15% coarse sand, ~5% fine subangular gravel, sand is subangular to rounded, very loose	MINE WASTE	Traffic Box set in Concrete	Begin drilling at 11:47
7040.3	1	Run 1								CLAYEY SAND with GRAVEL (SC): mottled gray (5Y 5/1), yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/4), moist, ~45% fines, ~20% fine sand, ~15% fine angular gravel, ~10% medium sand, ~5% coarse sand, ~5% coarse angular to subangular gravel, sand is subangular to subrounded, low plasticity, no dilatancy, very stiff, medium dry strength, iron oxide staining on gravels and in the sandy zones At 2.3-2.9 ft: contains ore rock, light greenish gray (5GY 8/1), yellowish		Cement Bentonite (3-5%) Grout; Casing - Schedule 40 PVC, 2" dia.	
7039.3	2												
7038.3	3												
7037.3	4												
7036.3	5	11:50 / 12:00											
7035.3	6	Run 2								At 5.7-6.5 ft: cobble zone of gray mineralized, silicified breccia			
7034.3	7									At 7-8 ft: increase in large gravels			
7033.3	8									At 8-8.9 ft: light gray (N 7/)			
7032.3	9												
7031.3	10	12:01 / 12:48								SANDY LEAN CLAY (CL): light brownish gray (10YR 6/2), moist, ~55% fines, ~20% fine sand, ~15% medium sand, ~10% coarse sand, sand is subangular to subrounded, non plastic, no dilatancy, very stiff, high dry strength		Stainless Steel Centralizer	
7030.3	11	Run 3								At 11.7 ft: sulfur crystals			
7029.3	12	12:48 / 13:02								At 12 ft: trace fine gravel			
7028.3	13	Run 4	SBL10181201										
7027.3	14									At 14-15 ft: large pieces of woody debris and twigs			
7026.3	15	13:02											



amec

See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-63S (CONT.)

Monitoring Well / Piezometer ID:PZ-50 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING
7025.3	16	Run 5 (13:05–13:05)							
7024.3	17								
7023.3	18	Run 6 (13:10–13:10)							
7022.3	19								
7021.3	20								
7020.3	21	Run 7 (14:27–14:27)							
7019.3	22								
7018.3	23								
7017.3	24	Run 8 (14:42–14:42)							
7016.3	25								
7015.3	26	Run 9 (14:54–14:54)							
7014.3	27								
7013.3	28								
7012.3	29								
7011.3	30								
7010.3	31								
7009.3	32								
7008.3	33								

LITHOLOGIC DESCRIPTION

SANDY LEAN CLAY (CL): continued
At 15.2-15.3 ft: contains small twigs, gray (N 5/)
At 15.8-16.9 ft: organic layer, mottled gray (N 5/), light greenish gray (5GY 7/1), reddish gray (2.5YR 5/1)
At 16.9-17.2 ft: gray (N 5/)
At 17.2-18.3 ft: ore rock with sulfur crystals, contains grass

CLAYEY SAND (SC): gray (2.5Y 5/1), olive brown (2.5Y 4/3) with brownish yellow (10YR 6/6) staining, moist, ~40% fine sand, ~35% medium sand, ~20% fines, ~5% coarse sand, sand is subangular to rounded, loose, iron oxide stained lenses and individual sand grains

SANDY LEAN CLAY (CL): mottled gray (10YR 5/1) and weak red (2.5YR 5/2), moist, ~55% fines, ~25% fine sand, ~15% medium sand, ~5% coarse sand, sand is subangular to rounded, low plasticity, no dilatancy, stiff, very high dry strength
At 20.7 ft: iron oxide staining along contact with cobbles
At 20.7-24.8 ft: zone of cobbles of ore rock with sulfur crystals and twigs and pine needles

LEAN CLAY with SAND (CL): black (10YR 2/1), moist, ~75% fines, ~10% medium sand, ~10% fine sand, ~5% fine subangular gravel, sand is subangular to subrounded, low plasticity, slow dilatancy, soft, medium dry strength, contains roots and rootlets

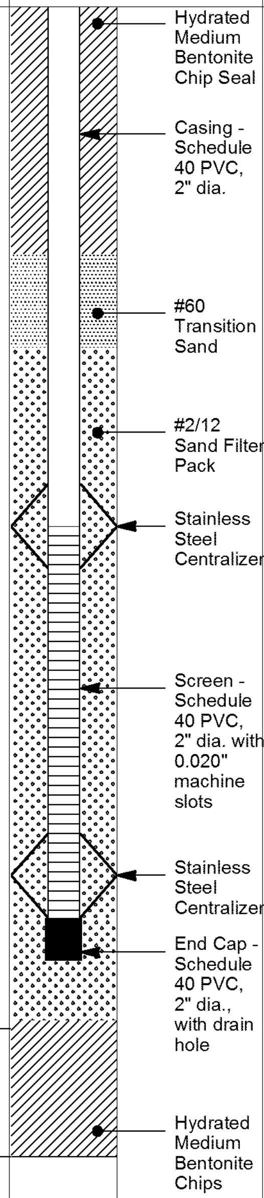
Bottom of boring at 28.5 ft bgs

GEOLOGIC MATERIAL

MINE WASTE

NATIVE SOIL

WELL SCHEMATIC



REMARKS

Stop drilling at 20 ft, boring open 10-20 ft, no water present.

Check for water, boring open 18-20 ft, no water present after waiting 65 minutes.

10/18/12
10/19/12

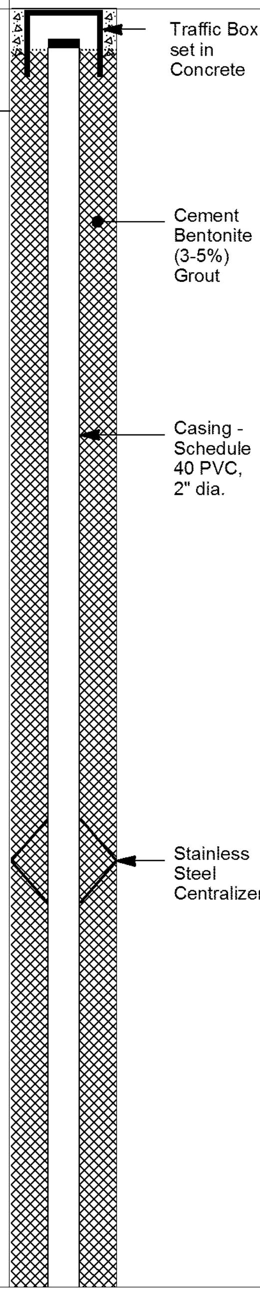
Stop drilling at 28.5 ft, boring open 18-28.5 ft, no water present after waiting overnight.

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company	**Log of Boring No.B-61** **Monitoring Well / Piezometer ID:PZ-51**

BORING LOCATION:	LCSA	ELEVATION (feet): 7041.22	NORTHING/EASTING: 2026037.03 N / 7228802.34 E
DRILLING CONTRACTOR:	Cascade Drilling, L.P.	DATE STARTED: 10/17/2012	DATE FINISHED: 10/19/2012
DRILLING EQUIPMENT:	Geoprobe 8140 LS track-mounted rig	TOTAL DEPTH (feet): 38.5	MEASURING POINT: Ground surface
DRILLING METHOD:	Sonic	DEPTH TO WATER (FIRST / COMPLETION): 28 feet / Dry	
SAMPLING METHOD:	4" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 22.1-26.6	TOC ELEVATION (feet): 7040.83
BOREHOLE DIAMETER:	6" (0-35') / 4" (35-38.5')	LOGGED BY: J. Browning	REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
	0	10:22 Run 1 10:24								SILTY SAND (SM): very pale brown (10YR 7/3), dry, ~85% fine to coarse angular sand, ~15% fines, loose	FILL	Begin drilling at 10:22
7040.2	1									SANDY LEAN CLAY with GRAVEL (CL): yellow (10YR 7/6) with mottled light greenish gray (5GY 7/1), yellow (2.5Y 8/8) and light red (10R 6/8), moist, ~50% fines, ~35% fine to coarse angular sand, ~15% fine to coarse angular gravel to 2.5-inch diameter, low plasticity, no dilatancy, stiff, low dry strength, trace rootlets to 8 ft	MINE WASTE	
7039.2	2	10:28 Run 2 10:30										
7038.2	3											
7037.2	4	10:32 R3 10:39										
7036.2	5	11:08 Run 4 11:10	SBL10171202									Blowcounts 5-5.5 ft: 7 5.5-6 ft: 7 6-6.5 ft: 12
7035.2	6											
7034.2	7											
7033.2	8	11:18 Run 5 11:20								At 8.5-9.5 ft: light greenish gray (10GY 8/1)		
7032.2	9											
7031.2	10	11:29 Run 6 11:33										
7030.2	11	11:39 11:49								At 11.4-12.5 ft: ore rock boulder, contains sulfur		
7029.2	12	11:55 12:00								At 12.5 ft: light greenish gray (5GY 7/1) with mottled yellow (10YR 8/6) and gray (N 5/), moist, trace organics, trace iron oxide staining		
7028.2	13	12:43 Run 9										
7027.2	14											
7026.2	15	12:45										

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-61 (CONT.)

Monitoring Well / Piezometer ID:PZ-51 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	TIME	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
7025.2 – 7023.2	16 – 18	Run 10	SBL10171204	13:25 – 13:26	GRAVELLY LEAN CLAY with SAND (CL): very pale brown (10YR 8/2) with mottled yellow (10YR 8/6), gray (N 5/) and light greenish gray (10GY 8/1), moist, ~65% fines, ~20% angular fine to coarse gravel to 1.5-inch diameter, ~15% fine to coarse angular sand, low plasticity, no dilatancy, stiff, low dry strength, trace organics, some iron oxide staining on clasts	MINE WASTE	Cement Bentonite (3-5%) Grout; Hydrated Medium Bentonite Chip Seal; Casing - Schedule 40 PVC, 2" dia.	Stop drilling at 15 ft, boring open 0-15 ft, no water present after waiting 20 minutes. Blowcounts 15-15.5 ft: 8; 15.5-16 ft: 14; 16-16.5 ft: 17
7022.2 – 7021.2	18 – 20	Run 11		13:31 – 13:32	LEAN CLAY with SAND (CL): light greenish gray (5GY 8/1), moist, ~80% fines, ~20% fine to medium angular sand, low plasticity, no dilatancy, stiff to very stiff, high dry strength, minor iron oxide staining	MINE WASTE	#60 Transition Sand	
7020.2 – 7019.2	20 – 22	Run 12	SBL10171205	14:28 – 14:30	At 22.6-23.2 ft: gray (2.5Y 6/1), medium plasticity, contains coarse angular sand	MINE WASTE	#2/12 Sand Filter Pack; Stainless Steel Centralizer	Stop drilling at 20 ft, boring open 10-20 ft, no water present after waiting 20 minutes. Blowcounts 20-20.5 ft: 13; 20.5-21 ft: 18; 21-21.5 ft: 27
7018.2 – 7016.2	23 – 25	Run 13		14:35 – 14:36	CLAYEY SAND with GRAVEL (SC): reddish yellow (7.5YR 6/6), moist, ~60% sand, ~25% fine to coarse angular to subangular gravel, ~15% fines, medium dense, iron staining throughout, visible water observed on surface of clasts	MINE WASTE	Screen - Schedule 40 PVC, 2" dia. with 0.020" machine slots	
7015.2 – 7014.2	25 – 27	Run 14	SBL10171206	15:35 – 15:37	SANDY LEAN CLAY (CL): light greenish gray (5GY 7/1), moist, ~70% fines, 20% fine to medium angular sand, ~10% fine to coarse angular gravel, low plasticity, no dilatancy, stiff, low dry strength	MINE WASTE	Stainless Steel Centralizer; End Cap - Schedule 40 PVC, 2" dia., with drain hole	Stop drilling at 25 ft, boring open 10-25 ft, no water present after waiting 30 minutes. Blowcounts 25-25.5 ft: 9; 25.5-26 ft: 14; 26-26.5 ft: 18
7013.2 – 7011.2	28 – 30	Run 15	SBL10171207	15:43 – 15:44	CLAYEY SAND with GRAVEL (SC): black (10Y 2.5/1), wet, ~50% fine to coarse angular to subrounded sand, ~25% fine to coarse subangular to subrounded gravel to 2.5-inch diameter, ~25% fines, strong organic odor, abundant rootlets and roots to 0.7-inch diameter At 29.2-30 ft: coarse gravel to 2.5-inch diameter	NATIVE SOIL	Hydrated Medium Bentonite Chips	Blowcounts 30-30.5 ft: 54; 30.5-30.6 ft: 50. Stop drilling at 31 ft, boring open 10-31 ft, DTW = 28 ft after waiting overnight. 10/17/12
7010.2 – 7008.2	31 – 33	Run 16		10:48 – 11:03; 11:14	POORLY GRADED GRAVEL with CLAY (GP-GC): dark gray (2.5Y 4/1), moist, ~80% cobbles, boulders and fine angular gravel, ~10% fine to coarse angular sand, ~10% clay, dense, cobbles and boulders composed of quartz latite porphyry (Tqlp)	COLLUVIUM		10/18/12 resumed drilling at 10:00. Hard drilling from 30-32 ft.

Column headers also printed: SAMPLE & RECOVERY, DEPTH TO WATER, FRACTURING, HARDNESS, STRENGTH, WEATHERING. Water level symbol ▽ at ~28 ft.

See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-61 (CONT.)
Monitoring Well / Piezometer ID:PZ-51 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
7007.2	34	Run 17								POORLY GRADED GRAVEL with CLAY (GP-GC): continued	COLLUVIUM	Hydrated Medium Bentonite Chips	Stop drilling at 37.5 ft, boring open 28-37.5 ft, DTW = 34.1 ft. Collect grab groundwater sample SBL10181202 using a stainless steel bailer (field parameters only).
7006.2	35	11:28 11:43					So	Fr	Se	QUARTZ LATITE PORPHYRY (Tqlp): light greenish gray (5GY 8/1), moist to 36.5 ft, then dry, highly altered with extensive iron oxide staining to 36.5 ft, weathered to lean clay with low plasticity, fine grained quartz, ~15% plagioclase, ~5% biotite, ~5% hornblende	BEDROCK		
7005.2	36	Run 18											
7004.2	37	11:45											
7003.2	38												
7002.2	39									Bottom of boring at 38.5 ft bgs			10/18/12 10/19/12 Check for water with boring open from 35-38.5 ft, no water present after waiting overnight.
7001.2	40												
7000.2	41												
6999.2	42												
6998.2	43												
6997.2	44												
6996.2	45												
6995.2	46												
6994.2	47												
6993.2	48												
6992.2	49												
6991.2	50												
6990.2	51												
6989.2	52												

See explanation sheet for descriptions of codes andsymbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company	**Log of Boring No.B-62** **Monitoring Well / Piezometer ID:PZ-52**		
BORING LOCATION: LCSA	ELEVATION (feet) 7041.44	NORTHING/EASTING 2026174.67 N / 7228713.15 E	
DRILLING CONTRACTOR: Cascade Drilling, L.P.	DATE STARTED: 10/25/2012	DATE FINISHED: 10/26/2012	
DRILLING EQUIPMENT: Geoprobe 8140 LS track-mounted rig	TOTAL DEPTH (feet): 22.5	MEASURING POINT: Ground surface	
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): NA / Dry		
SAMPLING METHOD: 4" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 7.1-11.6	TOC ELEVATION (feet): 7041.13	
BOREHOLE DIAMETER: 6" (0-14') / 4" (14-22.5')	LOGGED BY: J. Browning	REVIEWED BY: J. Klein, PG 8341	

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
	0	10:15 Run 1								SANDY LEAN CLAY with GRAVEL (CL): dark gray (5YR 4/1) matrix with mottled dark gray (N 4/), greenish gray (10Y 6/1), reddish brown (5YR 5/4) and pale yellow (5Y 8/4) clasts, moist, ~60% fines, ~25% fine to coarse angular to subangular sand, ~15% fine to coarse angular to subangular gravel to 2.4-inch diameter, low plasticity, no dilatancy, stiff	MINE WASTE	Traffic Box set in Concrete	Begin drilling at 10:15
7040.4	1											Hydrated Medium Bentonite Chip Seal	
7039.4	2									At 2-2.6 ft: pinkish white (7.5YR 8.5/2) and very dark gray (N 3/) mottling, hydrocarbon odor		Casing - Schedule 40 PVC, 2" dia.	
7038.4	3												
7037.4	4											#60 Transition Sand	
7036.4	5	10:18 / 10:23 Run 2								At 4.7-6 ft: greenish gray (10GY 6/1), ~10% fine to coarse gravel		#2/12 Sand Filter Pack	
7035.4	6												
7034.4	7	10:25 / 10:34 R3										Stainless Steel Centralizer	
7033.4	8	10:39 / 10:40 Run 4										Screen - Schedule 40 PVC, 2" dia. with 0.020" machine slots	
7032.4	9									At 9-9.5 ft: ~15% fine to coarse gravel to 3-inch diameter			
7031.4	10	10:42 / 11:06 Run 5											Stop drilling at 10 ft, boring open 0-10 ft, no water present after waiting 22 minutes.
7030.4	11											Stainless Steel Centralizer	
7029.4	12	11:08 / 11:09 Run 6								SILTY SAND with GRAVEL (SM): reddish yellow (7.5YR 7/6) matrix with white (10YR 9/1) clasts, moist, ~50% fine to coarse angular sand, ~25% fines, ~25% fine to coarse angular gravel, medium dense, iron oxide staining At 12.6-13.2 ft: mixed with organics		End Cap - Schedule 40 PVC, 2" dia., with drain hole	
7028.4	13										NATIVE SOIL	Hydrated Medium Bentonite Chips	
7027.4	14									SANDY LEAN CLAY with GRAVEL (CL): black (10YR 2/1), moist, ~50% fines, ~35% fine to coarse angular sand, ~15% fine to coarse angular gravel to 2-inch diameter, low			
7026.4	15	11:12											

See explanation sheet for descriptions of code and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

CLIENT: Atlantic Richfield Company

Log of Boring No.B-62 (CONT.)

Monitoring Well / Piezometer ID:PZ-52 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		13:00 Run 7 13:17	SBL10251201							plasticity, no dilatancy, stiff to very stiff, strong organic odor, rootlets and roots to 0.8-inch diameter	COLLUVIUM		Stop drilling at 15 ft, boring open 13-15 ft, no water present.
7025.4	16									SANDY LEAN CLAY (CL): very dark gray (N 3/) matrix with weak red (5R 4/4) and white (7.5YR 9/1) clasts, moist, ~50% fines, ~40% fine to coarse angular sand, ~10% fine to coarse angular to subangular gravel to 1-inch diameter, low plasticity, no dilatancy, slight organic odor, trace roots to 0.25-inch diameter		Hydrated Medium Bentonite Chips	Blowcounts 15-15.5 ft: 10 15.5-16 ft: 33 16-16.5 ft: 33
7024.4	17												
7023.4	18	13:25 Run 8 13:35								SILTY SAND (SM): greenish gray (10Y 5/1), moist, ~80% fine sand, ~20% fines, dense, trace roots to 0.25-inch diameter, trace iron oxide staining			
7022.4	19						Lo	We	Mo	SANDSTONE: light olive gray (5Y 6/1), composed of fine to medium subangular to subrounded sand grains, well sorted, some silt, weathered and intermixed with colluvium above to 20 ft, then massive, minor silt laminations, trace iron oxide staining, some quartz-rich sand	BEDROCK		
7021.4	20	14:10 Run 9 14:13											Stop drilling at 20 ft, boring open 14-20 ft, no water present after waiting 10 minutes.
7020.4	21												
7019.4	22												Stop drilling at 22.5 ft, boring open 14-22.5 ft, no water present after waiting 17 minutes.
										Bottom of boring at 22.5 ft bgs			
7018.4	23												
7017.4	24												
7016.4	25												
7015.4	26												
7014.4	27												
7013.4	28												
7012.4	29												
7011.4	30												
7010.4	31												
7009.4	32												
7008.4	33												

amec

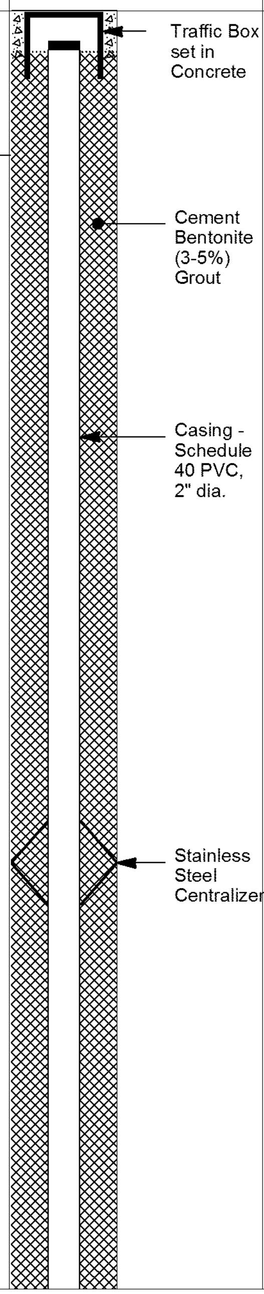
See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE, Alpine County, California CLIENT: Atlantic Richfield Company	**Log of Boring No.B-64** **Monitoring Well / Piezometer ID:PZ-53**	
BORING LOCATION: LCSA	ELEVATION (feet): 7041.11	NORTHING/EASTING: 2026555.98 N / 7228433.12 E
DRILLING CONTRACTOR: Cascade Drilling, L.P.	DATE STARTED: 10/24/2012	DATE FINISHED: 10/26/2012
DRILLING EQUIPMENT: Sonic Corp. 50K truck-mounted rig	TOTAL DEPTH (feet): 38	MEASURING POINT: Ground surface
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): NA / Dry	
SAMPLING METHOD: 4" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 29.7-34.2	TOC ELEVATION (feet): 7040.81
BOREHOLE DIAMETER: 6" (0-38')	LOGGED BY: M. Kairouz	REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
	0	Run 1 (14:14–14:14)								WELL-GRADED SAND (SW): light gray (10YR 7/2), dry, ~30% fine sand, ~30% medium sand, ~30% coarse sand, ~5% fine angular gravel, ~5% fines, sand is angular to subangular, loose	FILL	Begin drilling at 14:14
7040.1	1											
7039.1	2									SANDY LEAN CLAY (CL): mottled gray (5Y 5/1), light greenish gray (5GY 7/1) and reddish gray (2.5YR 5/1), moist, ~50% fines, ~15% fine sand, ~15% medium sand, ~15% coarse sand, ~5% fine angular gravel, sand is angular to subrounded, low plasticity, no dilatancy, very stiff, medium dry strength, trace iron oxide staining coating some gravel, gravel and sand consist primarily of volcanic lithics and quartz grains	MINE WASTE	
7038.1	3											
7037.1	4											
7036.1	5	Run 2 (14:30–14:30)								At 5-7 ft: crushed silicified breccia boulder, grayish orange (10YR 7/4), dry, ~70% fines, ~15% fine sand, ~10% medium sand, ~5% coarse sand, sand is angular to subangular, loose, no reaction with HCl		
7035.1	6											
7034.1	7											
7033.1	8									SANDY LEAN CLAY (CL): mottled gray (5Y 5/1), light greenish gray (5GY 7/1) and reddish gray (2.5YR 5/1), moist, ~50% fines, ~15% fine sand, ~15% medium sand, ~15% coarse sand, ~5% fine angular gravel, sand is angular to subrounded, low plasticity, no dilatancy, very stiff, medium dry strength, trace iron oxide staining coating some gravel, gravel and sand consist primarily of volcanic lithics and quartz grains At 9-9.5 ft: gravelly zone consisting of gray ore rock with disseminated pyrite At 9.8-12 ft: orange iron oxide stained, sandier zones with vertical to subvertical staining patterns		
7032.1	9											
7031.1	10	Run 3 (14:44–14:44)										
7030.1	11											
7029.1	12		SBL10241204							At 12-13 ft: light greenish gray (10Y 7/1), weathered ore rock gravelly and clayey zone		
7028.1	13	Run 4 (14:56–14:56)								At 13-13.2 ft: iron oxide staining, increase in sand content		
7027.1	14									CLAYEY SAND (SC): mottled dark grayish brown (10YR 4/2) and olive gray (5Y 5/2), moist, ~40% fines, ~25% fine sand, ~20%		
7026.1	15											

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

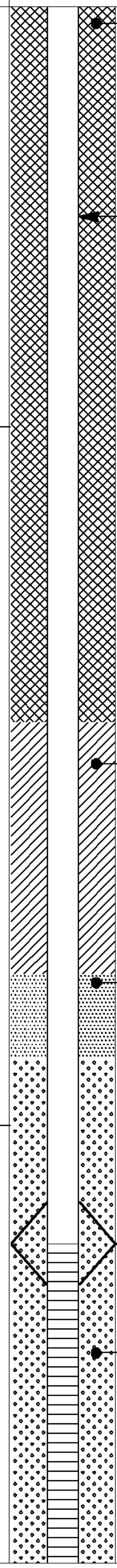
Project No. 13091

Log of Boring No.B-64 (CONT.)

Monitoring Well / Piezometer ID:PZ-53 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
		15:00								CLAYEY SAND (SC): continued medium sand, ~10% coarse sand, ~5% fine gravel, sand is angular to subrounded, medium dense, gravels are altered volcanics	MINE WASTE	
7025.1	16	Run 5										
7024.1	17	15:00 / 15:08								At 17.5 ft: iron oxide staining		
7023.1	18											Stop drilling at 21 ft, boring open 18-21 ft, no water present after waiting 30 minutes.
7022.1	19	Run 6								At 19.5 ft: iron oxide staining		
7021.1	20									FAT CLAY with SAND (CH): black (10YR 2/1), moist, ~70% fines, ~15% fine sand, ~5% medium sand, ~5% coarse sand, ~5% cobbles, sand is subangular to rounded, medium plasticity, no dilatancy, soft, very high dry strength, contains twigs, grasses, roots	NATIVE SOIL	
7020.1	21	15:08 / 9:58	SBL10241205									10/24/12 / 10/25/12 Stop drilling at 21 ft, boring open 20-21 ft, no water present after waiting overnight.
7019.1	22	Run 7										
7018.1	23	9:58 / 10:07										
7017.1	24	Run 8								GRAVELLY LEAN CLAY (CL): very dark brown (7.5YR 2.5/2), moist, ~60% fines, ~30% coarse angular gravel and cobbles, ~10% fine subangular to rounded sand, low plasticity, no dilatancy, medium stiff, very high dry strength, contains roots, gravels and cobbles composed primarily of basalt		
7016.1	25											
7015.1	26	10:07 / 10:28										
7014.1	27	Run 9										
7013.1	28									FAT CLAY (CH): very dark brown (7.5YR 2.5/2), moist, ~95% fines, ~5% fine sand, high plasticity, slow dilatancy, soft, very high dry strength, homogeneous	COLLUVIUM	
7012.1	29	10:28 / 12:00										Stop drilling at 29 ft, boring open 25-29 ft, no water present after waiting 1 hour.
7011.1	30	Run 10										
7010.1	31											
7009.1	32	12:00 / 12:08										
7008.1	33	Run 11										

WELL SCHEMATIC



PROJECT: LEVIATHAN MINE SITE
Alpine County, California

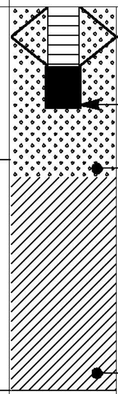
CLIENT: Atlantic Richfield Company

Log of Boring No.B-64 (CONT.)

Monitoring Well / Piezometer ID:PZ-53 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
7007.1	34	Run 11								FAT CLAY (CH): continued	COLLUVIUM	Stop drilling at 37.5 ft, boring open 25-37.5 ft, no water present after waiting 30 minutes.
7006.1	35	12:08 / 12:28										
7005.1	36	Run 12					Mo	We	Mo	SANDSTONE: grayish brown (5YR 3/2), iron oxide stained, primarily medium grained, moderately well sorted grains comprised of angular to subangular volcanic lithics and rounded quartz crystals, some stained orange	BEDROCK	
7004.1	37											
7003.1	38	12:29								Bottom of boring at 38 ft bgs		Stop drilling at 38 ft, boring open 37-38 ft, no water present after waiting 2.5 hours.
7002.1	39											
7001.1	40											
7000.1	41											
6999.1	42											
6998.1	43											
6997.1	44											
6996.1	45											
6995.1	46											
6994.1	47											
6993.1	48											
6992.1	49											
6991.1	50											
6990.1	51											
6989.1	52											

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

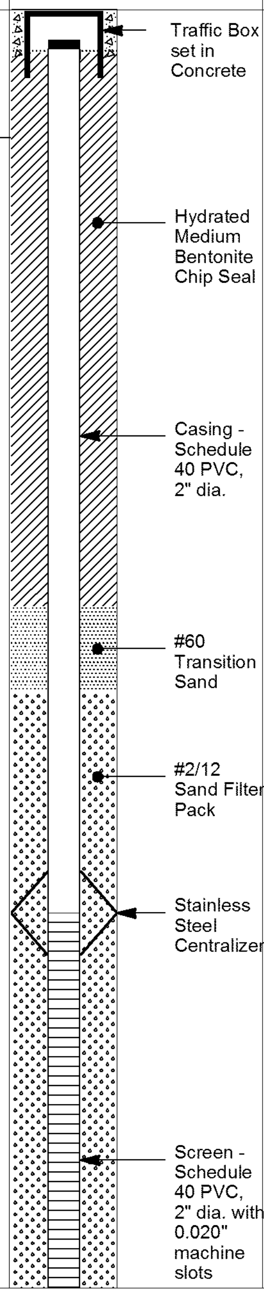
amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE Alpine County, California CLIENT: Atlantic Richfield Company	**Log of Boring No.B-64S** **Monitoring Well / Piezometer ID:PZ-54**
BORING LOCATION: LCSA	ELEVATION (feet): 7041.12 — NORTHING/EASTING: 2026560.75 N / 7228425.6 E
DRILLING CONTRACTOR: Cascade Drilling, L.P.	DATE STARTED: 10/26/2012 — DATE FINISHED: 10/29/2012
DRILLING EQUIPMENT: Sonic Corp. 50K truck-mounted rig	TOTAL DEPTH (feet): 23 — MEASURING POINT: Ground surface
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): NA / Dry
SAMPLING METHOD: 4" & 6" Sonic core tool	SCREEN INTERVAL (feet): 10.6-20.1 — TOC ELEVATION (feet): 7040.75
BOREHOLE DIAMETER: 6" (0-23')	LOGGED BY: M. Kairouz — REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
7041.1–7036.1	0–5	Run 1 (14:41–14:41)								WELL-GRADED SAND (SW): light gray (10YR 7/2), dry, ~30% fine sand, ~30% medium sand, ~30% coarse sand, ~10% fine angular gravel, sand is angular to subangular, loose	FILL	Begin drilling at 14:41
										SANDY LEAN CLAY (CL): mottled gray (5Y 5/1), light greenish gray (5GY 7/1), strong brown (7.5YR 5/6) and grayish brown (2.5Y 5/2), moist, ~50% fines, ~20% fine sand, ~10% medium sand, ~10% coarse sand, ~5% fine angular gravel, ~5% coarse angular gravel, sand is angular to subrounded, low plasticity, no dilatancy, very stiff, medium dry strength, some iron oxide staining, particularly around coarser areas and gravel	MINE WASTE	
7036.1–7031.1	5–10	Run 2 (14:56–14:57)								At 5-8.8 ft: crushed silicified ore rock boulder, dark yellowish orange (10YR 6/6), dry, ~70% fines, ~15% fine sand, ~10% medium sand, ~5% coarse sand, sand is angular to subangular, loose, no reaction with HCl	MINE WASTE	
										CLAYEY SAND (SC): mottled grayish brown (2.5Y 5/2), strong brown (7.5YR 5/6), very pale brown (10YR 7/3) and gray (10YR 5/1), moist, ~45% fines, ~20% fine sand, ~15% medium sand, ~10% coarse angular gravel, ~5% fine angular gravel, ~5% coarse sand, sand is angular to subangular, stiff	MINE WASTE	
7031.1–7029.1	10–12	Run 3 (15:02–15:02)								At 10.7-11.1 ft: intermixed with crushed silicified rock At 11.1-11.6 ft: zone of iron oxide staining	MINE WASTE	
7029.1–7026.1	12–15	Run 4 (15:21–15:21)								At 14.3-15 ft: gravel consists of gray silicified breccia (ore rock) with disseminated pyrite	MINE WASTE	

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

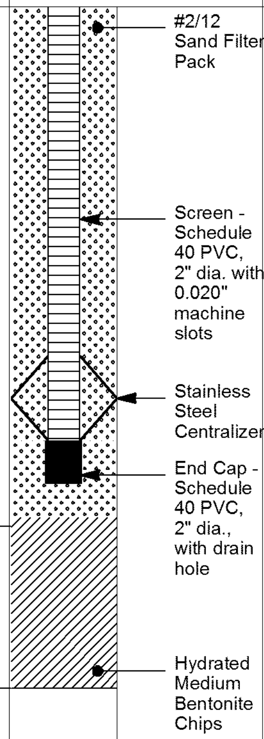
CLIENT: Atlantic Richfield Company

Log of Boring No.B-64S (CONT.)

Monitoring Well / Piezometer ID:PZ-54 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	SAMPLE & RECOVERY	DEPTH TO WATER	FRACTURING	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
		15:35								CLAYEY SAND (SC): continued	MINE WASTE	
7025.1	16	Run 5										
7024.1	17									At 16.7-21.1 ft: olive gray (5Y 4/2), moist, ~40% non plastic fines, ~25% fine sand, ~25% medium sand, ~5% coarse sand, ~5% coarse angular gravel and cobbles, sand is angular to subrounded, medium dense, sand comprised of red and dark gray volcanic and quartz crystals		
7023.1	18	15:35 15:39										
7022.1	19	Run 6								At 18.6-19.8 ft: increase in lean clay and gravel, pervasive orange iron oxide staining		
7021.1	20											
7020.1	21	15:39 15:49								FAT CLAY with SAND (CH): black (N 2.5/), moist, ~75% fines, ~15% fine sand, ~5% medium sand, ~5% fine gravel, sand is subangular to rounded, high plasticity, slow dilatancy, medium stiff, very high dry strength, contains roots	NATIVE SOIL	
7019.1	22	Run 7								At 22.3-23 ft: iron oxide stained, reddish yellow (7.5YR 6/6), increase in gravel and cobbles		
7018.1	23	15:49										10/26/12 10/29/12
7017.1	24									Bottom of boring at 23 ft bgs		Stop drilling at 21 ft, boring open 20-21 ft, no water present after waiting overnight.
7016.1	25											
7015.1	26											
7014.1	27											
7013.1	28											
7012.1	29											
7011.1	30											
7010.1	31											
7009.1	32											
7008.1	33											

WELL SCHEMATIC



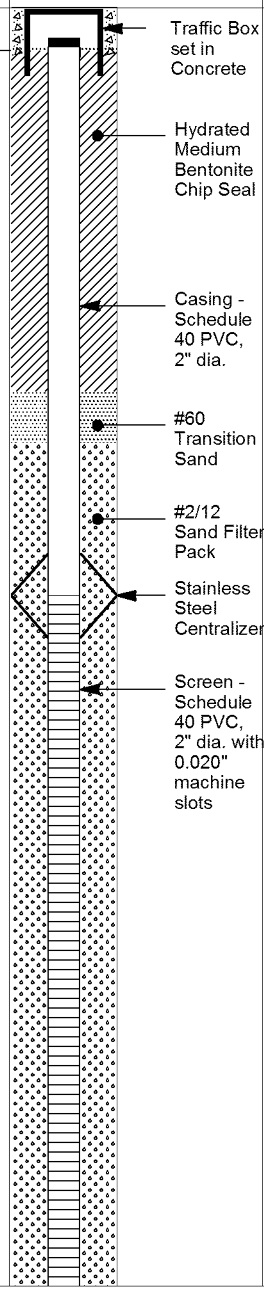
See explanation sheet for descriptions of codes and symbols.

Project No. 13091

PROJECT: LEVIATHAN MINE SITE, Alpine County, California	**Log of Boring No.B-66**
CLIENT: Atlantic Richfield Company	**Monitoring Well / Piezometer ID:PZ-55**
BORING LOCATION: LCSA	ELEVATION (feet): 7041.27 / NORTHING/EASTING: 2026248.01 N / 7229014.65 E
DRILLING CONTRACTOR: Cascade Drilling, L.P.	DATE STARTED: 10/29/2012 / DATE FINISHED: 10/30/2012
DRILLING EQUIPMENT: Geoprobe 8140 LS track-mounted rig	TOTAL DEPTH (feet): 27.5 / MEASURING POINT: Ground surface
DRILLING METHOD: Sonic	DEPTH TO WATER (FIRST / COMPLETION): NA / Dry
SAMPLING METHOD: 4" Sonic core tool & CA mod. split-spoon	SCREEN INTERVAL (feet): 6.9-21.4 / TOC ELEVATION (feet): 7041.05
BOREHOLE DIAMETER: 6" (0-22') / 4" (22-27.5')	LOGGED BY: J. Browning / REVIEWED BY: J. Klein, PG 8341

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	REMARKS
	0	Run 1 (12:35–12:36)		SILTY SAND (SM): very pale brown (10YR 7/3), dry, ~80% fine to coarse angular sand, ~20% fines, loose	FILL	Begin drilling at 12:35. Soil sample SBL10291201 collected from 0-0.5 ft.
7040.3	1			SAND LEAN CLAY with GRAVEL (CL): light yellowish brown (10YR 6/4) matrix with reddish yellow (5YR 6/6), pale yellow (5Y 7/4), white (7.5YR 9.5/1) and light bluish gray (10G 7/1) clasts, moist, ~60% fines, ~35% fine to coarse angular to subangular sand, ~15% fine to coarse angular to subangular gravel, low plasticity, no dilatancy, stiff	MINE WASTE	
7039.3	2		SBL10291204			Soil sample SBL10291203 collected from 2-2.5 ft.
7038.3	3	Run 2 (12:40–12:43)				
7037.3	4		SBL10291207			
7036.3	5					Soil sample SBL10291206 collected from 5-5.5 ft.
7035.3	6	Run 3 (13:40–13:42)		At 5.6-6 ft: dark bluish gray (5B 4/1)		
7034.3	7			SILTY SAND with GRAVEL (SM): reddish yellow (5YR 6/6) matrix with white (7.5YR 9/1) clasts, moist, ~50% fine to coarse angular to subangular sand, ~25% fine to coarse angular to subangular gravel, ~25% fines, medium dense, iron oxide stained throughout		
7033.3	8	Run 4 (13:45–13:47)				
7032.3	9			SANDY LEAN CLAY with GRAVEL (CL): dark gray (10YR 4/1) matrix with red (10R 5/6), gray (N 6/) and white (7.5YR 9/1) clasts, moist, ~50% fines, ~35% fine to coarse angular to subangular sand, ~15% fine to coarse angular to subangular gravel (to 3-inch diameter), low plasticity, no dilatancy, stiff At 10 ft: trace cobbles (to 3.5-inch diameter)		
7031.3	10					
7030.3	11	Run 5 (13:50–13:52)				
7029.3	12		SBL10301201	SANDY LEAN CLAY (CL): mottled gray (10YR 5/1), light greenish gray (10Y 7/1) and dusky red (2.5YR 3/2), moist, ~70% fines, ~25% fine to medium angular sand, ~5% fine to coarse angular to subangular gravel, low plasticity, no dilatancy, very stiff, minor iron oxide staining		
7028.3	13					
7027.3	14	Run 6 (13:55–)				
7026.3	15					

WELL SCHEMATIC



See explanation sheet for descriptions of codes and symbols.

amec

Project No. 13091

PROJECT: LEVIATHAN MINE SITE
Alpine County, California

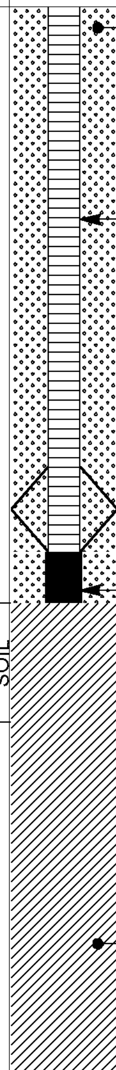
CLIENT: Atlantic Richfield Company

Log of Boring No.B-66 (CONT.)

Monitoring Well / Piezometer ID:PZ-55 (CONT.)

ELEVATION (feet)	DEPTH (feet)	RUN	SAMPLE NUMBER	HARDNESS	STRENGTH	WEATHERING	LITHOLOGIC DESCRIPTION	GEOLOGIC MATERIAL	WELL SCHEMATIC	REMARKS
		Run 6					SANDY LEAN CLAY (CL): continued	MINE WASTE	#2/12 Sand Filter Pack	
7025.3	16	13:57 / 14:00								
7024.3	17	Run 7							Screen - Schedule 40 PVC, 2" dia. with 0.020" machine slots	
7023.3	18	14:02 / 14:10					At 18-20 ft: abundant iron oxide staining			
7022.3	19	Run 8								
7021.3	20	14:12 / 15:13	SBL10291208				At 20 ft: ~50% fines, ~45% fine to coarse angular to subangular sand, ~5% fine angular gravel, some iron oxide staining			Blowcounts 20.5-21 ft: 22 21-21.5 ft: 34 21.5-22 ft: 60 22.5-23 ft: 19 23-23.5 ft: 44 23.5-24 ft: 65
7020.3	21	Run 9							Stainless Steel Centralizer	
7019.3	22	15:15 / 15:53	SBL10291209				CLAYEY SAND (SC): black (7.5YR 2.5/1), moist, ~65% fine to medium angular sand, ~25% fines, ~10% fine angular to subangular gravel, dense, trace roots and rootlets, moderate organic odor, quartz latite clasts	NATIVE SOIL	End Cap - Schedule 40 PVC, 2" dia., with drain hole	Stop drilling at 22.5 ft, boring open 0-22.5 ft, no water present after waiting 30 minutes.
7018.3	23	Run 10		So	Fr	Se	QUARTZ LATITE PORPHYRY (Tqlp): very light gray (N8) with brownish gray (5YR 4/1) clay stringers, moist, fine grained quartz, ~15% plagioclase, ~5% biotite, ~5% hornblende, minor iron oxide staining, highly weathered	BEDROCK		
7017.3	24									Stop drilling at 27.5 ft, boring open 10-27.5 ft, no water present after waiting 20 minutes.
7016.3	25	15:55 / 16:09					At 24.7 ft: dry, less weathered, no iron oxide staining			
7015.3	26	Run 11		Lo	Mo	Mo	At 26 ft: moderately weathered, massive		Hydrated Medium Bentonite Chips	
7014.3	27	16:13					Bottom of boring at 27.5 ft bgs			10/29/12 10/30/12
7013.3	28									Check for water with boring open 22-27.5 ft, no water present after waiting overnight.
7012.3	29									
7011.3	30									
7010.3	31									
7009.3	32									
7008.3	33									

Column headings also printed: SAMPLE & RECOVERY, DEPTH TO WATER, FRACTURING



amec

See explanation sheet for descriptions of codes and symbols.

Project No. 13091

amec foster wheeler

APPENDIX C

2015 through Mid-2016 Transducer Data (on CD)